EQUITY-BASED CHILDHOOD IMMUNIZATION POLICY-MAKING IN URBAN PUBLIC HEALTH UNITS ACROSS THE CANADIAN PRAIRIES: A COMPARATIVE STUDY

A Thesis Submitted to the College of

Graduate and Postdoctoral Studies

In Partial Fulfillment of the Requirements

For the Degree of Doctor of Philosophy

In the Department of Community Health and Epidemiology

University of Saskatchewan

Saskatoon

By

Thilina Bandara

Permission to use

In presenting this thesis in partial fulfillment of the requirements for a Postgraduate degree from the University of Saskatchewan, I agree that the Libraries of this University may make it freely available for inspection. I further agree that permission for copying of this thesis in any manner, in whole or in part, for scholarly purposes may be granted by the professor or professors who supervised my thesis work or, in their absence, by the Head of the Department or the Dean of the College in which my thesis work was done. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of Saskatchewan in any scholarly use which may be made of any material in my thesis. Requests for permission to copy or to make other uses of materials in this thesis in whole or part should be addressed to:

Dean
College of Graduate and Postdoctoral Studies
University of Saskatchewan
116 Thorvaldson Building, 110 Science Place
Saskatoon, Saskatchewan S7N 5C9
Canada

Address of the department:
Head of the Department of Community Health and Epidemiology
Health Science Building
107 Wiggins Road
University of Saskatchewan
Saskatoon, Saskatchewan
S7N 5E5
Canada

Abstract

Inequities in childhood immunization coverage rates increase the risk of disease outbreaks among vulnerable populations. This study assessed inequities in childhood measles, mumps and rubella (MMR) immunization coverage of four major cities across the Canadian prairies and the public health practices that were deployed to reduce inequities. One-dose by age-two MMR coverage rate inequities-over-time-measurements, and a policy-based inquiry into public health practices between 2009 and 2015 were conducted for each case study city. The results show that there were substantial differences in inequities between the provinces. The Saskatchewan case cities both exhibited low but increasing coverage rates, and large but reducing coverage inequities, over the study period. The Albertan case cities exhibited high coverage rates throughout the study period, with predominantly low inequities, except at a neighbourhood-coverage level, in both cities. These results suggest that there are provincial differences in immunization policy and programming practices. For the Saskatchewan cases, geographically-based epidemiology, visual management initiatives, and targeted interventions led to successful public health efforts to reduce coverage inequities. Reminder-based interventions were reported as successful initiatives to increase coverage rates across all cases. Finally, in Alberta, a measles outbreak occurred during the study period, and the subsequent intensive efforts in Calgary differentially reached high-income and high home-ownership neighbourhoods. Overall, the study suggests that when public health units detect local MMR coverage inequities and make intentional evidence-based efforts, they can be successful in reducing MMR coverage inequities.

Acknowledgments

I would like to thank my thesis committee: Dr. Cordell Neudorf, Dr. Nazeem Muhajarine, Dr. Marwa Farag and Dr. Daniel Béland. Their guidance throughout this process has been invaluable as I learned to navigate many different types of methodologies, focussing me towards conducting a coherent study and analysis. I am also grateful to them for encouraging me to take on new projects and experiences along the way, while also being patient with me while I navigated my varied interests in and around the field of population health.

I also want to thank the incredible peers that I had the good fortune of working with along my journey. Having the chance to chat about academic life and all things research were formative experiences in student solidarity. Being in it together with such bright minds was an honour.

I am grateful for my funders, the National Science and Engineering Research Council and the Government of Saskatchewan. I want to specifically thank those who chose me for the NSERC funding, the faculty members of the Integrated Training Program in Infectious Disease, Food Safety and Public Policy (ITraP) both for giving me the financial freedom to be a full-time student, and for the educational and experiential opportunities the program provided me.

Lastly, I am grateful to the eager members of the Urban Public Health Network, public health staff whom I interviewed, analysts whom I bothered and Sam Herold from the Canadian Institute for Health Information for providing me with data, analysis and their time.

Dedication

I dedicate this dissertation to my family: My father, mother and sister, all of whom know the academic life well and have supported me throughout my career. It was a PhD journey of his own that brought my father and us to the University of Saskatchewan. I am honoured to follow in his footsteps at this exceptional institution.

I also dedicate this to my wife, Chelsea Gordon, with whom I began my relationship mere weeks before beginning this PhD program. I am eternally grateful for her unwavering support of my scatterbrained pursuits since. I've never loved and have never learned as deeply as I have over the last six years, and I look forward to continuing to do both with her for many years to come.

Table of Contents

List of figures

List of tables

Chapter 1 : Introduction

The achievement of equity in health is an internationally shared goal. Globally, there is ample research regarding the pervasiveness of health inequities, and increasingly improving methods are yielding high-resolution findings regarding this issue. To expedite the health equity agenda worldwide the World Health Organization is calling for the "third-wave" of health equity research – studies that investigate what it will take to reduce health inequities in populations. Local action is emphasized as critical to the reduction of equity gaps, where organizations can be highly engaged and reflexive in shaping a more equitable society (WHO et al., 2010).

In Canada, health inequities persist across various indicators, including diabetes, obesity, and mental illness, and yet there is a paucity of research in what is called "the solutions space", defined by the WHO as research exploring "the strategic drivers of reductions in health disparities, the differential health effects of policy interventions, and the impact of alternative options for enhancing equity" (WHO et al., 2010). To address the underlying complexities of health inequities, researchers must assess how policies and programs *do* influence the trajectory of these trends. It is also true that the relationship between health inequalities research and policy has always been a tenuous one where researchers and advocates are generally frustrated with the lack of political action on the social determinants of health (Asthana & Halliday, 2006; Embrett & Randall, 2014). In Canada, there has been very little research assessing at what *local* agencies have done to accomplish health equity.

One key indicator of health inequities in a population is childhood immunization coverage rates. Immunisation programs are among the most effective public health measures in reducing the burden of infectious disease and as such, have immediate utility in the evaluation of health policy and service delivery. In the United States, the CDC regards childhood immunizations as a primary vector through which health care service providers can help reduce overall inequities. In these efforts, they have made tremendous strides in reducing vaccine-preventable diseases overall, as well as in low socio-economic

status groups (CDC, 2014). Equitable coverage ensures that vulnerable populations, who are more likely to be exposed to pathogens and less likely to have access to preventative services, will have long-term protection against disease (Brearley, Eggers, Steinglass, & Vandelaer, 2013; CDC, 2014b). Consideration of equity takes deliberate targeting of programs and policies. Through economic modelling, targeting low-coverage groups has shown to be more efficient than targeting high-coverage groups. This approach also has the benefit of reducing health inequities (National Institute for Health and Clinical Excellence, 2009). Childhood vaccinations programming is a specific health care service that local public health agencies have immediate influence over in Canada and is a potential indicator of whether public health institutions can and do engage in reducing health inequities. In Canada, there is very little research on how pervasive equity gaps are in childhood immunizations, and if there are, which regions have had success in reducing the gaps.

Addressing the social determinants that lead to inequitable childhood vaccination coverage requires specific intentionality on behalf of public health units. In general, guidelines pertaining to research and action around addressing the social determinants of health stress the importance of going beyond the scope of traditional health research that focuses on strictly "medical" interventions – from examining only downstream individual factors to assessing upstream higher-level processes. There is a large gap in the literature on which kinds of equitable policies and programs work in Canada, and what specific drivers exist within a public health program that facilitate equitable public health responses. This shift in perspective to upstream factors requires a re-evaluation of strategies that are presently employed by population health researchers, because as researchers move from the "medical to the social domain", so must their tools be able to account for this increasing analytical complexity (Asthana & Halliday, 2006). Across the country, local public health institutions are becoming sensitized to health inequities as awareness of the social determinants of health increases. There is, however, little evidence of whether public health units have reduced equity gaps.

To assess public health action on health inequities I investigate the health equity trends over time of Measles, Mumps and Rubella (MMR) childhood vaccination coverage in four cities across the Canadian prairies. I use MMR vaccination coverage as an indicator for inequities across various health regions for three reasons: 1.) MMR coverage data is among the simplest health indicator to procure due to its relatively high availability and low-risk privacy considerations; 2.) Only two doses are needed to be considered up-to-date; 3.) Childhood immunizations are a universally covered and administered preventative health service over which local public health agencies have direct influence, and; 4.) Changes to MMR coverage policy will likely result in a more immediate change to the outcome (coverage) than for those made for diabetes or obesity policies for example, where the time-frame for changes to outcomes may be decades. Once health inequity trends over time are established, a policy-based inquiry unearths steps that public health have taken to help reduce inequities in MMR coverage across urban centres in the Canadian prairies. The specific research questions I am pursing with this study are listed below:

Chapter 2 : Research Questions

Which urban public health units have reduced MMR coverage inequities in the Canadian Prairies between 2009 and 2015?

After realizing the limitations of MMR data across the country through engagements with the Urban Public Health Network as the research partner, this research question reflects the scope of data we were able to procure, focusing question to Calgary, Edmonton, Saskatoon and Regina urban centres between the years of 2009 and 2015. The answer to this question informs a 'portrait' of MMR coverage inequities across the cities, revealing the state of equitable childhood immunization outcomes, that go on to provide context to answers of the second research question.

Which interventions and/or policies have contributed to reducing inequities and where?

Based off of the MMR inequities detected by answering the first research question, of the cities that showed improvements, I investigate what intervention and/or policies worked to reduce inequity gaps. The answers to this question unearth important public health practices that have either been shown in the literature to work previously in other contexts, and others that are novel to these case cities. These practices can then be scrutinized further against existing theories of public health practice.

Chapter 3 : Background Literature

3.1 Health inequalities, health inequities and the social determinants of health

Health inequalities refer to the differences in health outcomes between populations. An example of a clear health inequality is the exclusive occurrence of cervical cancer in women, when compared to men. The cause of the inequality can often be considered inherently unavoidable, as with the biologically-determined inequality in cervical cancer, as men do not biologically produce a cervix. When the cause is, however, due to unjust, unavoidable and unnecessary circumstances disproportionately affecting one population over the other, an inequality is then considered an *inequity (*W.H.O., 2017). The WHO defines health inequities as "*avoidable* inequalities in health between groups of people within countries and between countries. These inequities arise from inequalities within and between societies. Social and economic conditions and their effects on people's lives determine their risk of illness and the actions taken to prevent them becoming ill or treat illness when it occurs" (W.H.O., 2017).

The social determinants of health are the social, political and economic factors that distinguish populations in health inequities. Specifically, they refer to the circumstances in which a population lives, works, ages, and plays, considering the social and physical contexts within which people exist. This lens is known as a socio-ecological perspective on health. Figure 3-1 illustrates a socio-ecological framework used by health promotion researchers and program developers to conceptualize the varying levels of influential determinants of health (King & King, 2010). The placement of the individual in the centre illustrates the significant permutations of interactions through which context is created. By gathering information on each level and researching how each interaction within the system occurs, better interventions can be developed to improve health status.

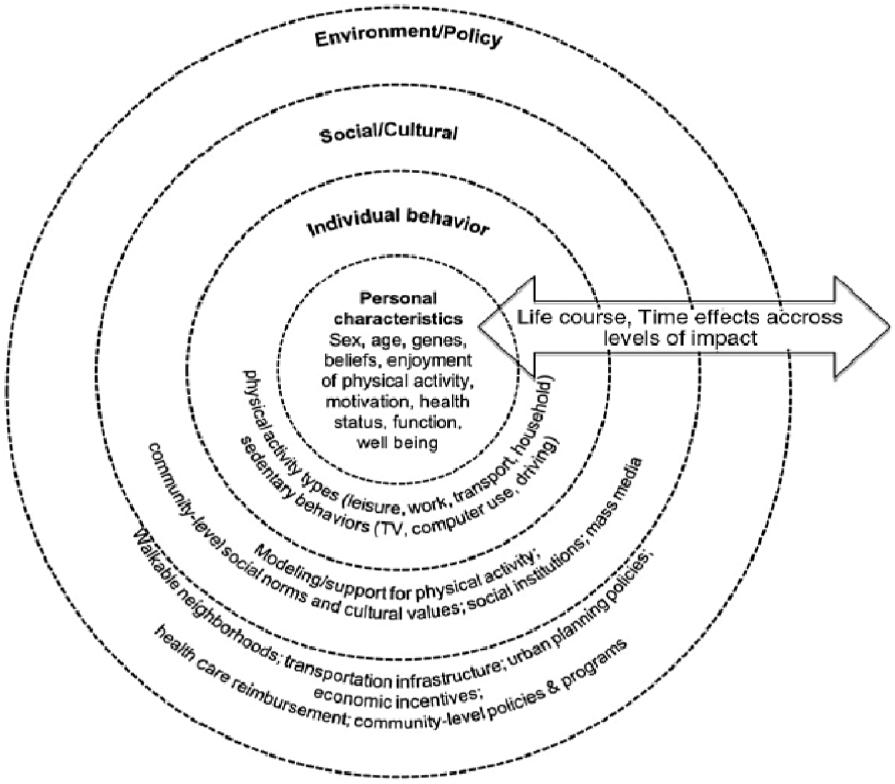


Figure 3-1: Socio-ecological framework for population physical activity promotion. Reprinted from: King A.C., King D.K. Physical Activity for an Aging Population. Public Health Reviews. 2010; 32:401-426. Creative Commons 4.0.

Some commonly researched social determinants of health include income, education, employment, and race/ethnicity differences between populations, and their relative effects on disproportionate health outcomes between these groups (W.H.O., 2017). Health inequities related to the social determinants of health are persistent in developed countries across the world. For example, in Canada, income-related mortality rates, fall injury, motor vehicle accident, diabetes, and infant mortality inequities are persistent, "with minimal progress made in reducing the health gap between lower- and higher-income Canadians over the past decade" (Canadian Institute for Health Information, 2015 p.17; Tjepkema, Wilkins, & Long, 2013). For the purposes of this study, I argue that every immunization coverage inequality measured *in this analysis* (associated with neighbourhood coverage, income, %-aboriginal, %-immigrant & %-home-ownership) represents an inequity, as the differences in coverage are attributed to geographical and social factors; all of which are unjust according to the principles of universal health care, and specifically in Canada, the *Canada Health Act* (Government of Canada, 2018).

3.2 Public Health Sector and Health Inequities

3.2.1 History

The W.H.O. considers the public health sector as a primary agent for action on health inequities (W.H.O., 2008). Access to data, analytical capability, and the leadership status afford the public health sector many of the necessary tools to be able to assess, research, lead and coordinate health equity action. This has led to multiple calls for public health agencies around the world to help in achieving health equity. To understand the role of public health in reducing health inequities, it is important to recognize how closely tied health equity and public health practice are historically. Several sources indicate that the modern institution of public health indeed began with and has since retreated from a health equity imperative (Awofeso, 2004; Fairchild, Rosner, Colgrove, Bayer, & Fried, 2010; Mckinlay & Ph, 1998; Raphael, Raphael, & Bryant, 2002; The Igham County Health Department, 2006).

The historical record of *modern public health institutions* starting from 19th century England show clear evidence of a health equity agenda. Together, Sir Edwin Chadwick's *Report on the Sanitary Conditions of the Labouring Population and on the Means of its Improvement* (Chadwick, 1842), Public Health Act of 1848 and Dr. John Snow's epidemiological studies on Cholera reinforced the notion that many of the social inequities formed in the industrial revolution that disadvantaged the growing number of poor in England, culminating in large health inequities (Fee & Brown, 2005). The understanding that deaths among the working class were avoidable during this period, and that the protection of the poor required government intervention resulted in the formalisation of public health governance structures in England (Sram et al., 2015). For example, the formal appointment of a "Medical Officer of Health" was one of three recommendations Chadwick made in his report, and is a title still used in modern public health practice (Chadwick, 1842).

Though it took many more decades of political debates, reforms to sanitation and establishment of local public health agencies and the vital statistic registrar were eventually established across England, proving the *Public Act of 1848* as a watershed document for public health policy (Fairchild et al., 2010; Rutty,

2010). Early public health legislation is also attributed to sparking the political and ideological movements around labour rights in post-industrial England (Sram et al., 2015). The *Public Health Act of 1848* embodies the deep history in public health for advocating health as being a "collective good, actively produced by institutions and social policies" (The Igham County Health Department, 2006, p.16). Concurrently, strides were being made in medicine to acknowledge the role of the social determinants of health, the most famous of which is attributed to Rudoph Virchow, a German physician who was among the first to publish extensively on the topic of the intersection of politics and health. His most famous and often cited quote being "Medicine is a social science, and politics nothing but medicine at a larger scale", was published in *Die Medicinische Reform* in 1848 (Mackenbach, 2009).

After colonization the North American continent experience with infectious diseases subsequently mirrored that of Britain. Cholera, typhoid, tuberculosis, influenza and smallpox disproportionally burdened the poor and Indigenous populations, exposing the need for action on behalf of the public health sector in Canada. As sanitation and immunization programming replaced basic quarantining tactics, an epidemiological shift occurred around the 1960s, from morbidity and mortality being increasingly associated with chronic diseases and injuries rather than with infectious diseases (Rutty, 2010). The following decades saw the release of the LaLonde Report of 1974 on the social determinants of health, the Epp report of 1986 on "Achieving health for all" and the WHO Ottawa Charter for Health Promotion, all advocating for action on upstream social factors associated with the new disease landscape in Canada and the world, placing Canada at the forefront of political agenda-setting on the social determinants of health (Jobse, Levy, & Adams, 2014). It was then ironically an infectious disease crisis, the 2003 SARS epidemic, that led to the creation of the Public Health Agency of Canada (PHAC), bringing together elements of Health Canada, the Laboratory Centres for Disease Control along with new resources in 2007. PHAC has since developed a broad population health management framework that they have begun to operationalize (Jobse, Levy & Adams, 2014; Rutty, 2010).

Between the 1970s and today, modern public health practice has focused on the prevention of the growing number of chronic diseases through the modification of lifestyle behaviours, in large part due to what Nancy Krieger identifies as an emphasis on understanding of the "web of causation" associated with the complex risk factors of diseases (Krieger, 1994). It is argued that "new public health" must return to its roots of understanding population health as a social and economic phenomenon, as Chadwick did in England. The National Association of County and City Health Officials (2006) attributes this mission as requiring a rethinking of the basic theoretical and practice tenets of public health. Indeed, in Canada, Jobse et al. (Jobse, Levy & Adams, 2014) argue that there is little evidence to suggest that aforementioned population health management framework has been implemented at all in public health practice nationally.

Progress on a 'new' public health agenda is described as difficult and slow. Public health agencies often lack an evidence base and conceptual frameworks with which to address issues of health equity in their respective jurisdictions. Because structural determinants of health generally involve issues of income, education and employment - all factors existing outside of the traditional public health legislative mandate - questions regarding what public health *can* and *should* do complicate action. In 2014, McLean's editor Peter Shawn Taylor argued in a Globe and Mail article that indeed, public health-led initiatives risk becoming *too* intrusive, particularly on issues of food security, and that public health agencies *should not* be involved in manner outside of health, rather, "stick(ing) to vaccines" (Taylor, 2014). Regarding what public health *can* do, in a review of the literature and key-informant interviews from public health professionals across Canada, the National Collaborating Centre for Determinants of Health found that the scope of the social determinants of health are often perceived as too large in scope for public health to handle, especially with limited resources (National Collaborating Centre for Determinants of Health, 2011). Jobse, Levy and Adams (2014) criticizes the current federal approach to working towards population health, citing that despite Canada being the vanguard of rhetoric around the social

determinants of health (the aforementioned reports of the 70's and 80's), there is little evidence that the Canadian public health enterprise actually implements population health-based solutions.

These caveats however, do not seem to dissuade the research or institutional interest of public health professionals to help achieve health equity. Reports and guidelines from around the world regarding health equity are overwhelmingly authored by public health professionals and departments of governments (Farrer & Marinetti, 2015; Friel, 2009; Leppo, K.; Ollila, E., Pena, S.; Wismar, M.; Cook, 2013; Rudolph, L; Caplan, J.; Ben-Moche, K.; Dillon, 2013; Shankardass, K.; Solar, O.; Murphy, K.; Freiler, A.; Bobbili, S.; Bayoumi, A.; O'Campo, 2011). In Canada, health equity is embedded into "The Five Core Competencies of Public Health Practice of the Public Health Agency of Canada" and appears often in the mandates of regional public health agencies (Department of Health New Brunswick, 2016; Ministry of Health and Long-Term Care, 2016; Public Health Agency of Canada, 2008; Public Health Observatory Saskatoon Health Region, 2014; Region of Peel, 2011; Vancouver Coastal Health, 2011; Winnipeg Regional Health Authority, 2012). The scholarly literature on the topic of the role of public health in health equity, however, is in a nascent phase in Canada, as a public health systems research agenda was only initiated in 2011.

3.2.2 Modern Public Health Practice in Canada:

3.2.2.1 Institutions and mandates

In Canada, public health services are primarily delivered at a regional and local level. In most provinces, these public health institutions operate within a larger health care regional authority and are funded through provincial taxation and federal transfer payments. The minority of public health institutions operate at a municipal-level in Canada and are funded through local taxation (Mowat & Butler-Jones, 2007). The services delivered by local public institutions include immunization planning and programming, health promotion activities, public health inspections, and local disease surveillance. Higher level coordination with provincial and federal public health agencies involves sharing of selective disease surveillance data, emergency preparedness planning, vaccine distribution protocols, and the

development of consistent public health standards. Formally in Canada, the six functions of public health are:

1. Population health assessment
2. Disease and injury surveillance
3. Health promotion
4. Disease and Injury Prevention
5. Health protection
6. Emergency preparedness and response (Mowat & Butler-Jones, 2007).

A concerted effort was made by the Canadian federal government to define and strengthen public health workforce capacity in Canada with the release of the Naylor Recommendations (Health Canada, 2003) and subsequent Joint Task Group on Public Health Human Resources Framework (Joint Task Group on Public Health Human Resources, 2005). Once the Public Health Agency was created in 2007, seven categories of core competencies were established, all requiring specialized advanced training to fulfill (Bell & Macdougall, 2013). Delving deeper into the *Core Competencies for Public Health in Canada: Release 1.0* (Public Health Agency of Canada, 2008) reveals that equity-based actions are federally recognized as intrinsic to effective public health practice in Canada. Under #1 "Public Health Sciences", it is mentioned that "a public health practitioner is able to…demonstrate knowledge about: the health status of populations, inequities in health, the determinants of health and illness…"; #2 "Assessment and Analysis": "A public health practitioner is able to…determine the meaning of information, considering the current ethical, political, scientific, socio-cultural and economic contexts"; and an entire competency dedicated to #5 "Diversity and Inclusiveness" (Public Health Agency of Canada, 2008).

Follow-up literature, however, regarding the Canadian public health workforce and their capacities is currently incomplete and consequently little is known about the differences in public health capacities between regions (Penny, 2014). Anecdotally, differences between regions are apparent, and are most often due to varying levels of funding and abilities to attract and retain skilled staff (Mowat & Butler -

Jones, 2007). Specifically regarding equity, studies from the United States indicate that equity-related public health work is highly dependent on human and capital resource availability, data and measurement capacities, and community engagement competency. For example, Cox found that 80% of public health departments in Massachusetts are inadequately staffed, lack training, and have budgets as low as $1,000 for every 40,000 people they provide services for, and that these deficiencies can make equity-related public health practice nearly impossible (Academy Health, 2009). With my study, I will contribute to the literature regarding equity-based policymaking in urban public health units in Canada.

3.23 Universal vs. targeted practice

Public health practitioners can utilize both universal and/or targeted approaches to improve population health and to reduce the health gaps between low socio-economic status groups and high socio-economic status groups.

Universal approaches are by design non-discriminatory in principle by removing eligibility criteria for access to a given treatment or intervention. Underlying this approach is Geoffery Rose's "Population strategy" where universal programs work to shift the distribution of population risk to a lower mean value (i.e. shifting the risk exposure curve to the left) (Rose, 2001). A population-based immunization program is an example of a universal program. Childhood MMR immunization programs, for example, target an entire region, where a local public health unit can work to increase coverage rates to a higher mean target. Two-doses of MMR vaccine are provided to all children, regardless of any socio-economic qualifiers, across Canada. For example, to meet a population target a local public health unit may increase the operating hours of all clinics in the region.

While comprehensive in scope, a universal approach to improving population health can have drawbacks. Universal programs run the risk of under-appreciating specific needs and barriers between groups and individuals and may result in an intervention that disproportionality advantages some groups over others, inadvertently *increasing* health inequities. For example, Frederico et al. (2007) showed that a population level education program to reduce smoking rates may bias towards being effective only to those with high

levels of education and health literacy; in other words, while mean smoking rates may decrease as a result of this intervention, those with a low education status are disproportionately left behind from the improvements.

Conversely, *targeted* approaches prioritize specific groups or individuals within the general population who need interventions that consider their specific risk factors. This requires robust data collection and analysis capacities to be able to stratify risk factors and creative program and policy-making capabilities to design tailored interventions. The groups that need specific targeting may be distinguished by their *individual* biological or behavioural risk factors (Lalonde's notions of "Populations at Risk"), or by their risk factors that are associated with their *social status* (Frolich & Potvin's "Vulnerable Populations") (Frohlich & Potvin, 2008).

The distinction between the two targeted intervention approaches is important to consider. Frolich & Potvin (2008) argue that Lalonde's "Populations at Risk" approach suffers from a similar (and previously mentioned) criticism of modern public health practice in general - of being too reliant on addressing individual-level risk factors. She emphasizes that this mindset can lead to victim-blaming, which can overtly stigmatize individuals. Moreover, focusing on individual behaviours only addresses symptoms, rather than root causes, of health inequalities, allowing new groups and individuals to constantly enter the risk profile. Conversely, by understanding 'risk' as a social phenomenon, the "Vulnerable Populations" approach considers the higher 'risk of risks' that groups are exposed to by being socially marginalized, often in more than one way. For example, low-income groups are likely also food insecure and/or have not completed secondary education. Through the Vulnerable Population perspective, the intersectionality of identities and risks of poor health are considered, harkening back to the aforementioned socio-ecological understanding of health where the social contexts of inequities are central to this public health program designing approach.

While being more nuanced, targeted approaches have their own limitations. Program designers must be careful when selecting the targeting criteria, as there is a risk of introducing exclusion errors (leading to

under coverage) or inclusion errors (leading to over coverage) into a targeted intervention. This can lead to overall inefficient public health practice. Targeted interventions can also lead policy-makers away from addressing the root social determinants of health, in a phenomenon called "lifestyle drift". A 2009 Marmot Review committee report defines "lifestyle drift" as "the tendency for policy initiatives on tackling health inequalities to start off with a broad recognition of the need to take action on the wider social determinants of health (upstream), but which, in the course of implementation, drift downstream to focus largely on individual lifestyle factors" (Hunter, Popay, Tannahill, Whitehead, & Elson, 2009, p.3). Here again emerges the ethos of the preoccupation with lifestyle interventions associated with modern public health practice.

3.2.3.1 Blended approaches

As knowledge and capacity grows within public health institutions to recognize health inequities, program designers and policy-makers can better balance the two approaches to meet all the needs of their population. What emerges is a blend of intervention elements in an approach that attempts to fulfill Rose's Population Strategy to reduce mean risk, while also attending to vulnerable populations in order to close the equity gaps.

A blended approach to policy making can be traced to the political science literature. In the social policy realm, Theda Skocpol (2001) describes "targeting within universalism" (targeted universalism), as a public policy-making approach to mitigate many of the shortcomings of a targeted approach, associated in her case, with the past failures of the United States governments' many attempts to address poverty in general. This approach involves devising strategies to benefit all levels of society, while building-in provisions for especially impoverished populations. An exemplary case of this, Skocpol writes, is the U.S. Social Security system:

"…once social security was established [1935 and thereafter] as virtually universal for employed Americans, its administrators worked to make benefits higher for everyone, and relatively better for the less privileged, so that benefits could be closer to a sufficient retirement income" (Skocpol, 2001, p.426).

She argues that this approach can reduce the social stigma associated with targeted approaches and can maximize political feasibility of a poverty-reducing intervention.

In Canada, the parlance used to describe the blended approach to public health action most resembles Skocpol's targeted universalism. The National Collaborating Centre for the Determinants of Health provides the following example of how "targeted universalism" works in Canadian public health practice:

> "A universal flu vaccine program can include a special outreach strategy for groups at higher risk of becoming ill, or those less likely to get the vaccine, including pregnant women, young children, seniors and Aboriginal populations. Strategies may include peer outreach, satellite venues, and partnering with community groups" (The National Collaborating Centre for Determinants of Health, 2013, p.3).

The literature on targeted universalism in public health in Canada is nascent, with few documented case examples.

In the European public health realm, a blended approach is described slightly differently. In the UK, Marmot advocates for "Proportional Universalism", in which he argues that programming and resources must be adapted to groups along the social gradient, according to *need*. However, Carey et al. argue that the definition of proportionate universalism in the literature, and how it actually operates in the real-world policy environments, are consistently misunderstood. What it means to public health practice particularly is often lost in the conversations of what governments as a whole must do to reduce inequities (Carey, Crammond, & Leeuw, 2015).

3.2.4 Immunizations and infectious diseases:

With respect to public health's role in reducing infectious disease outcomes, the approach is largely a universal one, with opportunities to adapt targeted-universal approaches. In Canada, vaccines to protect against 15 diseases are publicly-funded for children and infants, with the Measles, Mumps, and Rubella

vaccination among them.[1] However, despite cost being removed as a barrier to immunization, only 89% of children are immunized with one-dose of the MMR vaccine by the age of 2 in Canada based on the 2013 National Immunization Coverage Survey estimates (Government of Canada, 2016).

3.2.4.1 Measles, Mumps and Rubella Immunizations

Measles is a uniquely highly contagious virus that has been reportable in Canada since 1924. Complications from Measles have historically led to significant mortality in Canada, reaching their highest in 1926 with 892 measles-associated deaths (A. King, Varughese, Serres, Tipples, & Waters, 2004). The Measles, Mumps and Rubella immunization was made universal in Canada in the early 1970s. As outbreaks continued, it was then recommended by the mid-1990s that a second dose was necessary to improve population immunity (Katz et al., 2004).

The implementation of this universal immunization coverage, however, is described as discordant across Canada:

> "…in contrast to other industrialized countries such as the United States, Australia and the United Kingdom, where single, harmonized countrywide immunization schedules are de rigueur, Canada has a confusing system, with each province and territory defining its own schedule…the patchwork of vaccine schedules creates access inequities and added safety (reliability) issues in our system
>
> For example, the second dose of the measles, mumps and rubella (MMR). Vaccine is given at 18 months in 9 provinces or territories, and at four to six years in three others. Moving at the 'wrong' age may mean a missed second dose and vulnerability to these infections later in life" (Macdonald, Bortolussi, & CP Society, 2011, p.1).

[1] DTaP-IPV-Hi: Diphtheria, Tetanus, acellular Pertussis, Inactivated Polio Virus, Haemophilus Influenzae type B vaccine; DTaP-HB-IPV-Hib: Diphtheria, Tetanus, acellular Pertussis, Hepatitis B, Inactivated Polio Virus, Haemophilus Influenzae type b vaccine; Tdap-IPV: Tetanus, diphtheria (reduced toxoid), acellular pertussis (reduced toxoid), Inactivated Polio Virus vaccine; Tdap: Tetanus, diphtheria (reduced toxoid), acellular pertussis (reduced toxoid) vaccine; Hepatitis A Vaccine; Hepatitis B vaccine; MMR: Measles, Mumps, Rubella; Var: Varicella; MMR-V: Measles, Mumps, Rubella, Varicella vaccine; Men-C-C: Meningococcal conjugate (Strain C) vaccine: Men-C-ACYW-135: Meningococcal conjugate (Strains A, C, Y, W135) vaccine; Pneu-C-13: Pneumococcal conjugate (13-valent) vaccine; Pneu-C-10: Pneumococcal conjugate (10-valent) vaccine; Rota: Rotavirus vaccine; HPV: Human Papillomavirus (Government of Canada, 2019).

The only commonality between provinces is that all children do receive at least one dose of MMR immunization by the age of two, therefore, one dose coverage rates were selected for the indicator of this study. It is important to note that choosing one-dose as the indicator most likely under-estimates the true inequity as the likelihood of inequities increase with the number of doses that required to achieve full immunity; two-dose MMR coverage by age 7, for example, will likely show more inequity that one-dose MMR coverage by age two. There is presently a dearth of information in the literature regarding inequities in MMR coverage, and how to reduce these inequity gaps, in Canada.

3.2.4.2 Herd Immunity and Equity

Herd immunity refers to "the indirect protective effects on unvaccinated individuals in a largely vaccinated group through reduced pathogen circulation and transmission" (Luyten et al., 2011, p. 286). The herd immunity threshold value, given in a percentage, indicates the minimum proportion of immunity needed to eliminate[2] disease incidence (Fine, 1993) and is calculated from the following equation:

Vc = (1-1/R0)./E

Vc is the critical minimum proportion of the immunized population needed; *Ro* is the basic reproduction number referring to the number of secondary infections one infected individual causes (magnitude depends on the disease in question); and *E* is the effectiveness of the vaccine (Fine, Eames, & Heymann, 2011).

Of the three diseases targeted in the MMR vaccination, measles is the most infectious, with a *Ro* between 12 and 18 (Fine, 1993). One dose of MMR vaccination is considered 93% effective *(E)* (Centers for Disease Control and Prevention, 2018). Therefore:

Vc = (1-1/R0)/E *100%
Vc = (1-1/12)/0.93 *100%
Vc = 98.5%

[2] *P.E.M. Fine defines "elimination" as "the regional eradication, or reduction of disease incidence to some tolerably low level, or else reduction of disease to zero without total removal of the infectious agent." (Fine, 1993, p.265)*

The conservative estimate for herd immunity threshold value for one dose of MMR vaccination against measles in a population is 98.5%. Two doses are reported as being 97% effective (*E*) against measles (Centers for Disease Control and Prevention, 2018), which then results in a 94.5% herd immunity threshold coverage rate.

Physical pockets of rates under 98.5% can create the conditions for disease transmission in a population. Small-area geographical analysis can assess where these physical pockets of susceptible individuals may exist, and by linking area-based demographic data with epidemiological data, researchers can assess the level of *inequitable vulnerability to measles infection* that may exists in a population. These analyses provide the basis for equity-based, targeted immunization programming conducted by public health units.

3.3 State of the Research

Reducing inequities in childhood immunizations requires both an understanding of *what* interventions work, and *how* to carry out successful public health practice (Brownson, Allen, Duggan, Katherine, & Erwin, 2012). Answering these two basic questions requires utilizing two prominent public health research fields: Population Health Intervention Research and Public Health System and Services Research, respectively.

3.3.1 The What: Population Health Intervention Research and Immunization policies and programs

According to the WHO's Commission on the Social Determinants of Health Framework (WHO, 2008), population health is the result of inter-related systems working through a multitude of institutional, professional, interpersonal and policy pathways that don't always necessarily involve the health system. Population Health Intervention Research (PHIR) utilizes this broad perspective and investigates population health through "the use of scientific methods to produce knowledge about policy and program interventions that operate within or outside the health sector and have the potential to impact health at the population level" (CIHR, 2016). The majority of studies investigating interventions to reduce inequities in immunization in OECD countries fall into the PHIR field.

3.3.1.1 Canada

There is currently no overall guiding document that assists Canadian public health agencies in reducing inequities in childhood immunizations. In 2015, the need for federal leadership on this issue was recognized as essential, and $25 million dollars was dedicated to moving the agenda forward in Canada. In the meantime, some Canadian public health agencies have been working to reduce inequalities locally. The two most-comprehensively documented childhood immunization-related PHIR projects come out of Manitoba and Saskatchewan.

In Manitoba, an intervention was launched as a part of the provincial "Family First" program, which itself included a cadre of maternal health services for vulnerable mothers. The program provides home visitations, where one of the elements was the delivery of promotional information about age appropriate vaccinations for children enrolled in the program. Isaac et al. (2015) examined the effect of this educational intervention and found that children enrolled in Family First showed an increase in complete vaccination rates compared to eligible children who are not enrolled in Families First. Home visitation is, however, cited as having low cost-effectiveness for the lone outcome of improving childhood immunization, which suggests that it may be a better model for integrated service delivery to address more than one health outcome (Isaac et al., 2015).

In Saskatchewan, the Saskatoon Health Region implemented a universal immunization reminder program involving 5 telephone calls, a letter, and a last-line home visitation. Their data showed that gains in immunization were made in the region overall, from 68.6 percent to 75.7 percent for two-doses of MMR by age-2. The gains made in the core, low-SES neighbourhoods were, however, not statistically significant. An evaluation of a telephone reminder program in 2007 and 2008 showed limited evidence that telephone reminders, or the addition of home visits, increase rates in low-income neighbourhoods. This study did, however, find that 81.8% of parents surveyed did not know that their child was behind, suggesting that an education campaign may increase rates itself (Lemstra et al., 2007). More recent reporting from the Saskatoon Health Region indicates that equity gaps have been closing since 2008 due

to more-appropriately targeted interventions, including home visits, the use of translations services, and embedding community ambassadors into low-income neighbourhoods to help families keep on schedule (Saskatoon Health Region, 2014).

3.3.1.2 United States

The majority of the documented PHIR and/or policy work regarding reducing disparities in coverage rates comes out of the United States. Two narratives emerge from the grey and peer-reviewed literature regarding decreasing childhood immunization inequities from the United States. One focuses on a federal, supply-side policy called Vaccine for Children; the other speaks to community and practice-based state and local-level interventions.

3.3.1.2.1 Vaccines for Children

Beginning in 1993, after a large federal initiative to eliminate the cost barrier for vaccinations in the United States, The Presidential Childhood Immunization Initiative led to the establishment of the Vaccine for Children (VFC) Program (CDC, 2014a), which provided federal monies to state and local health departments specifically to 1.) Recruit & monitor private providers for VFC; 2.) Oversee vaccine ordering activities; and 3.) Properly Store VFC vaccines. This program provided low-cost vaccinations to children who were Medicaid-eligible, uninsured, American Indian or Alaskan Native, and/or the underinsured by providing the vaccine free-of-charge to providers (Centres for Disease Control and Prevention, 2016). A CDC racially-stratified analysis of vaccination rates between 1995 and 2011 show a massive reduction of disparities over the course of the VFC program, ultimately showing no racial disparities for MMR rates. MMR rates also exceeded 90% for most years since 1994 (CDC, 2014a).

VFC primarily worked through reducing the cost barrier for vulnerable populations and eliminating it for providers. The secondary goal of this program was to strengthen and incentivize the use of “the medical home” model for children and adolescence care, which refers to a pediatric care strategy that emphasizes “continuous, comprehensive, family centred, coordinated, compassionate and culturally effective” pediatric care by one health care provider who is familiar to the given community and family. This aspect

of VFC signalled a shift in immunization delivery in the United States, where this new financing model led to increasing *private* provider immunizations given, and a reduction in *public* immunization delivery (Szilagyi et al., 2002; Zimmerman et al., 2001). Smith et al. (2005) found that VFC-eligible children who received ongoing private medical home-modeled care were more likely to be up-to-date than those without a medical home.

3.3.1.2.2 State and Local

Local community and practice-based interventions in the United States have shown to reduce childhood immunization inequities. The best evidence involves complex interventions utilizing community outreach, more inclusive promotional materials, reminders, and home visits. The most notable U.S.-based complex interventions to reduce inequalities involve public health departments and researchers targeting at-risk children and using population-based promotional material, direct parental/child education, patient recall and reminder systems, and to a lesser extent community outreach programming and health care worker-targeting education, in multi-pronged immunization programs. Regarding the community outreach element, a 2010 Cochrane review utilizing mostly U.S. based literature reported an overall positive effect of the use of lay healthcare workers improving childhood immunizations rates (Lewin et al., 2010).

The most comprehensive and successful study cited in Crocker-Buque et al.'s systematic review on the topic of reducing childhood immunization inequities (Crocker-Buque, Edelstein, & Mounier-Jack, 2016) comes out of Washington D.C., where Fu et al. (2012) conducted an intervention involving 6 health centres, where they implemented all of the CDC Task Force recommendations (Community Prevention Services Task Force, 2010) that were relevant to outpatient pediatric practice, and added a community partnership component, in order to improve immunization rates in low-socioeconomic status populations. The program elements included:

1.) Collaboration with community

2.) Provider reminder/recall & assessment with feedback from providers

3.) Expanding access in clinical settings by providing immunizations at both sick and well visits

4.) Involving standing orders for physicians

5.) Monthly client reminders/recall service delivery

6.) Poster and pamphlet educational interventions

7.) Providing vaccinations at nutrition programs for at-risk mothers

The combination of these practices improved 4:3:1:3:3:3:1:3[3] coverage rates by 16% (to 87%) and improved the series completion rate of coverage by 14% (to 79%), in their targeted publicly-insured population (Fu et al., 2012).

3.3.1.3 Europe

In Europe, the W.H.O. spearheads the Tailoring Immunization Programme, where regional offices support local agencies to operationalize the W.H.O. *Guide to Tailoring Immunization Programmes* (W.H.O. European Region, 2013). The document itself does not endorse any specific intervention, rather is it "a diagnostic guide to define and diagnose behaviourally related hesitancy determinants and propose appropriate interventions" by:

(1). Identifying and prioritizing vaccine hesitant populations and subgroups

(2). Diagnosing the demand and supply-side barriers and enablers for vaccination in these populations; and

(3). Designing evidence-informed responses to vaccine hesitancy appropriate to the setting, context and hesitant population (Butler, Macdonald, & SAGE Group, 2015, p. 4177).

The guide makes a specific reference to Muscat's "Who gets Measles in Europe?" (2011) article to emphasize that social determinants of health are inextricably linked to the other factors, such as vaccine opposition and information asymmetry, associated with vaccine hesitancy and coverage. There is a paucity, however, of literature regarding actual interventions to reduce coverage inequities in Europe

[3] 4 diphtheria-tetanus-pertussis vaccines, 3 poliovirus vaccines, 1 measles-mumps-rubella vaccine, 3 Haemophilus influenzae type b vaccines, 3 hepatitis B vaccines, 1 varicella vaccine, and three 7-valent pneumococcal conjugate vaccines

outside of the United Kingdom. Crocker-Buque et al. posits that this lack of comprehensive European literature may be due to publishing language restrictions and unavailability of data in regions outside of the UK (Crocker-Buque et al., 2016).

Two UK studies targeting two low-socioeconomic status/low coverage boroughs showed that both a complex intervention and an updated, streamlined reminder/recall practice improved childhood immunization coverage. The complex intervention carried out in London borough of Hamlet increased one-dose MMR coverage nearly 14% in two years, reaching near herd-immunity levels at 94%, in response to a 2008 outbreak of measles involving 1370 cases. The intervention included geographically coordinated clinic networking, financial incentivizing of networks to reach immunization targets, improved information technology implementation, peer review of practice among networks, and continuous cleaning of data (Cockman, Dawson, Mathur, & Hull, 2011). A successful recall/reminder campaign in the Wandsworth, England in 2011 showed that clinics with an improved recall/reminder workflow and IT capacity had 13.8% higher coverage rate that the non-intervention group (Atchison, Zvoc, & Balakrishnan, 2013). Another outbreak in 2013 led to an MMR action plan being developed by Public Health England. Regarding equity, it called for targeted education campaigns, for general practitioners (GP's) to utilize databases to identify and outreach 10-16-year old children who require catch-up, and *local* plans to be developed for vulnerable/hard to reach population outreach by public health departments. Simon et al.'s evaluation of the GP catch program showed a 0.5% increase in coverage after the campaign in London, reaching their target of 95% at the midpoint mark of their intervention (Simone et al., 2014).

Overall, the population health intervention research literature exploring the topic of childhood immunization coverage inequities provides clues to which interventions work better than others. The theme of employing a reminder-recall system is almost universally recommended but may not be sufficient in practice to reach all populations. The most successful campaigns to reduce inequities appear to be the result of more complex interventions, involving a combination of health care providers,

community members, and patients, and adapting a rich understanding of specific barriers facing under-immunized populations to craft targeted public health interventions.

3.3.2 The How: Public Health Systems and Service Research (PHSSR).

Health system research (HSR) is the field of inquiry through which researchers assess how health system-level pathways can be improved, with the goal of providing the best evidence to improve healthcare delivery to populations. It must be recognized, however, nested within the health care system, the *public* health system is unique in its mandate and capacity, and is among the primary public entities held accountable to improve population health. The recent increased interest in strengthening public health systems to address issues like global pandemics, environmental disasters, and threats of bioterrorism further emphasize the need to research the public health care system itself (Pauly, MacDonald, Hancock, Martin, & Perkin, 2013). It is with this recognition that a unique branch of health system research has emerged in the literature over the last decade: Public Health Systems and Service Research (Thomas, Corso, & Monroe, 2015).

Conceived as a branch of Health Services Research, Public Health System and Service Research (PHSSR) began in the United States with a mandate to understand the unique organizational capacities public health agencies possess when compared to the rest of the healthcare system. Described as a 'American' distinction, PHSSR is "an area of scientific inquiry that uses a number of research disciplines and perspectives to examine the organization of public health systems, how they are financed, how they deliver public health services, the quality and costs of services they deliver, and the impact of variations in all these areas on population health" (Scutchfield & Ingram, 2013, p. 2).

Schutzfield traces PSSHR to the early 20th century, where descriptive studies on the resource compositions of public health agencies paved the way for present day public health organizational standards. While the disease landscape changed throughout the decades, so did the need for public health system reform, and with each new era of public health issues came new assessments on the purpose of these organizations to continue to prevent disease and maintain population health. Presently, the Centres

for Disease Control and Prevention, Robert Wood Johnson Foundation and the National Institutes of Health have supported numerous PSSHR initiatives and have been successful in bringing about evidence-based public health policy changes, particularly in HIV and teen pregnancy prevention, as well as in hospital-acquired infection surveillance (Scutchfield & Ingram, 2013). A systematic review of methods used in PSSHR, however, uncovered that the field is still rife with "primitive set of research activities", needing an evolution beyond short-term studies, to investigate more longitudinal assessments of public health systems (Harris et al., 2012). Schutzfield also emphasizes the especially-salient need for PSSHR research to be translated into practice through the development of closer relationships between local health departments and academic institutions (Scutchfield, Howard, & Mays, 2012).

The cornerstone American PHSSR research involves a long-running national longitudinal public health survey. Since 1998, a representative cohort of U.S. communities' public health agencies have been periodically assessed to discern the structures and functions of local public health delivery systems over time. Using a validated survey instrument, local public health officials report information about a set of 20 activities identified the IOM 1988 consensus report on public health, that are widely considered to be core elements of public health practice at the local level, which are closely correlated with the Essential Public Health Services framework now widely used in practice (Institute of Medicine, 1998; University of Kentucky & Robert Wood Johnson Foundation, 2017). The National Longitudinal Survey has provided American researchers with rich data describing their public health system, allowing them assess typologies of public health systems across the country and giving them the ability to track changes in public health activities over time (Mays, 2012; Mays, Scutchfield, Bhandari, & Smith, 2008).

3.3.2.1 PHSSR and Equity in the United States

Equity is an essential pillar of the PHSSR in the United States, as outlined in their 2012 research agenda:

> "Social determinants of health and health disparities:

17. What public health strategies are most effective in addressing health disparities and/or social determinants of health at local, state, and national levels?

18. How do the organizational, financial, and workforce characteristics of public health agencies and their partners influence the implementation and effectiveness of strategies to address health disparities and/or social determinants of health at local, state, and national levels?

19. How do disparities in access to information and communication technologies among public health practitioners and the communities they serve affect the effectiveness, efficiency, and outcomes of public health strategies, particularly for racial and ethnic minority and low-income populations?

20. What policy, system, and administrative strategies are most effective in reducing disparities in the effectiveness, efficiency, and outcomes of public health strategies delivered to racial and ethnic minority and low-income populations?" (Swamy et al., 2012, p. S75).

To this effect, several studies have investigated equity-based public health practice at a system-level. The literature largely highlights local public health action to reduce health inequities.

The theme of data is central to the body of American equity-related PHSSR. Shah et al. report significant implementation cost, staff burden, and skill-gap barriers that faced Boston and Los Angeles county health departments in their attempts to build capacity to provide data-driven solutions to rampant inequities (Shah, Russo, Earl, & Kuo, 2014). A study involving Minnesota's local public health departments found that equity-related practice is often hindered by a lack of data linking the social determinants of health and health outcomes. There are also low reported levels of institutional support for public health action on health inequities (Peterson-Hickey & Edelman, 2013). Lawson et al. (2013) report a high variation in the usage of high-resolution socio-economic data among Connecticut local health departments, largely dependent on geographic location of the departments and the level leadership seniority. 'Better Data' was also a central recommendation made by U.S. public health experts in order to shift public health practice towards advancing health equity (Knight, 2014).

Other equity-related PHSSR have explicated inequities in public health service delivery. Nationally, Hilliard and Boulton's (2012) assessment of 25 years of public health workforce data reports overall dwindling numbers of public health personnel due the economic downturn of 2008/2009 and an aging workforce. Follow-up work from the survey by Bekemeier shows the overall cuts disproportionately decreased public health capacity in jurisdictions with a high percentage of Black populations, while increasing the capacity in jurisdictions with a high percentage of Hispanic populations (Bekemeier, 2013). Nationally, Mays (Mays & Hogg, 2015) also found communities experiencing the largest unemployment rates saw the sharpest reductions in local public health delivery between 2006 and 2012. At a local level, in Los Angeles, Kominski & Bastani (2013) reported that despite the close proximity of HPV clinics to high-risk neighbourhoods, coverage rates were still inadequately low, suggesting a lack of effective targeted programs and policies for vulnerable populations. In an example of upstream PHSSR, Gibson et al. report disparities in municipal water supply services in Wake County, North Carolina (Gibson, Defelice, Sebastian, & Leker, 2014), finding that with every 10% increase in the proportion of African American population in a census block, there is a 3.8% increase in the odds of exclusion of municipal water services.

3.3.2.2 PHSSR in Canada

Despite the mid-2000 government enthusiasm around public health capacity, and the detailed description of this policy history (Rutty, 2010), there is a distinct lack of follow-up and ongoing Canadian PHSSR research. This, despite a mobilization in 2011 by public health researchers and practitioners to develop a PHSSR research agenda, which was not followed up or ratified in any meaningful way (Strosher, MacDonald, & Hancock, 2011). This has led to a scattered landscape of peer-reviewed publications that investigate the Canadian Public Health system. Since the inciting incident of SARS, what has emerged, however, is a well-connected public health *practice* network brimming with publicly-available grey literature reports, spearheaded by the Canadian National Collaborating Centres (NCC) for Public Health. This network is made up of 6 centres: NCC for Aboriginal Health; NCC for Determinants of Health; NCC for Healthy Public Policy; NCC for Environmental Health; NCC for Infectious Diseases; and the NCC for

Methods and Tools, all with the mandate “to promote the use of scientific research and other knowledge to strengthen public health practices, programs and policies in Canada” (National Collaborating Centres for Public Health, 2017).

The most salient and organized Canadian PHSSR research comes from the University of Victoria, where the initial attempt to consolidate Canadian PHSSR research began in 2007, and provincial developments have been made through collaborations with British Columbia and Ontario government agencies (Macdonald & Pauly, 2015). An assessment of public health human resource policy documents in these two provinces conducted by Regan et al. had laid the foundations for the future necessary assessment of the contemporary public health workforce in Canada. Overall, however, the PHSSR activity in Canada is described as “in its infancy with relatively few committed researchers” as of 2014 (Macdonald & Pauly, 2015). The current study is designed to contribute to the emerging field of PHSSR in Canada.

Chapter 4 : Frameworks Used in This Study

My study is designed to consider the basic principles of PHIR and PHSSR in evaluating local equity-based public health policy-making, by specifically utilizing an “equity lens” to investigate the policies and procedures that drive the delivery of successful, equitable, public health interventions. This involves a practice-based approach, utilizing the real-world perspectives of the public health programs in each region. The following frameworks compromise the base on which my research is predicated. The figure below illustrates the utility of each framework outlined in each section where each framework contributed in the process of designing the final framework utilized in the study. The top of the figure represents the broadest perspective informing the study: Brownson et al.’s (2012) Evidence-Based Public Health Policy. The path then branches off, showing which frameworks were used to elucidate the “Process and Content” and “Outcomes” domains, respectively. Each framework is explained throughout this section, ending on an explanation of study framework.

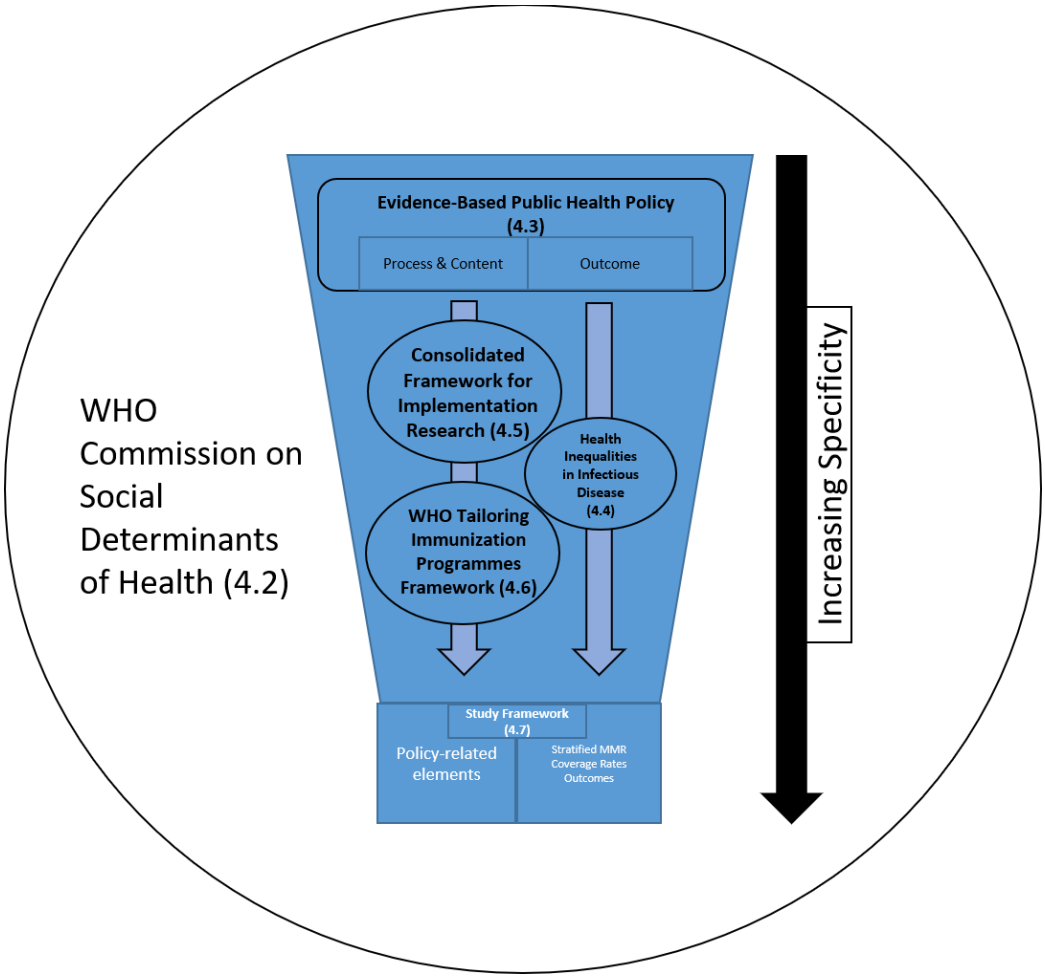


Figure 4-1: Diagram of frameworks from the literature used to develop study framework

4.1 WHO Commission on Social Determinants of Health Framework

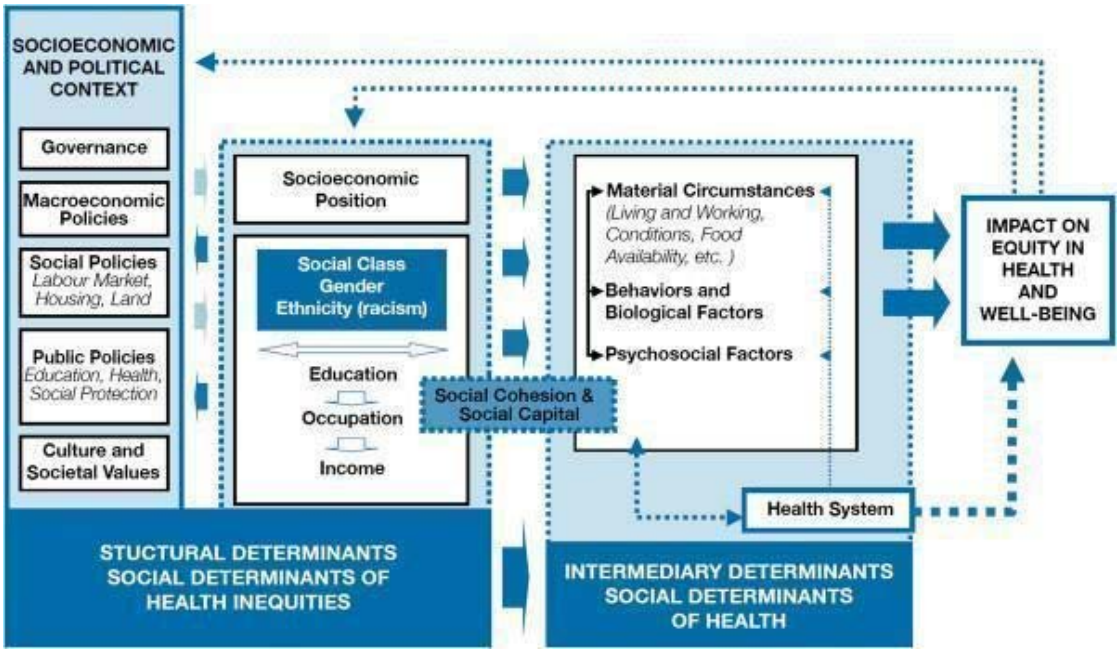


Figure 4-2: A Conceptual Framework for Action on the Social Determinants of Health. Reprinted from Solar, O., & Irwin, A. (2010).

The WHO Commission on the Social Determinants of Health Framework explicates the levels of social and political factors that influence the health status of populations. In the context of immunizations, the W.H.O. cites Muscat (2011), who suggest that poor access to health care due to a multitude of reasons (time, transportation, money) is a major factor for under-immunization (WHO European Region, 2013). They suggest that the social determinants of health listed have implications for public health policy-making and that integrating the intermediary and structural factors into decision-making produces more effective targeted immunization interventions. This framework is used widely throughout the health equity literature in Canada and forms the basis for the equity-based quantitative and qualitative inquiry of this study. As equity is a primary goal of public health practice, this framework informs the entirety of the study and provides the lens through which the data is collected, analyzed and synthesized.

4.2 Evidence-based Public Health Policy

Evidence-based practice is a pillar of public health practice in Canada (Public Health Agency of Canada, 2008). Brownson et al. defines evidence-based public health policy-making as the following: “To

improve public health outcomes, evidence-based policy is developed through a continuous process that uses the best available quantitative and qualitative evidence." (Brownson, Chriqui, & Stamatakis, 2009, p. 1580). Their framework describes three domains of evidence-based policy that I will utilize to describe and assess equity-based policy making in Saskatoon, Regina, Calgary, and Edmonton urban centres: 'Process' to understand the procedures that affect the likelihood of policy adoption, 'Content' of specific policies to improve public health, and 'Outcome' that delineates the impact of policies. My intention is to uncover process (policy-making), content (interventions) and outcomes (coverage rates) for each case study to evaluate the policy narratives that emerge to evaluate if indeed, these case cities utilize evidence to inform their policies. The data sources for "Process" include key-informant interviews as well as published case study literature, and the "Content" sources include both key-informant interviews and content analysis of policy documents. "Outcome" data is sourced through local epidemiological surveillance systems of the case cities, and available literature pertaining to immunization-related initiatives over the study period. To detect the intricacies of "Process" and "Content" specifically, constructs from Frameworks 4.4 and 4.5 were used (see additional frameworks later in the chapter). Framework 4.3 informed the rationale of the health-inequalities-over-time "Outcome" measurements.

4.3 Health inequalities in infectious diseases

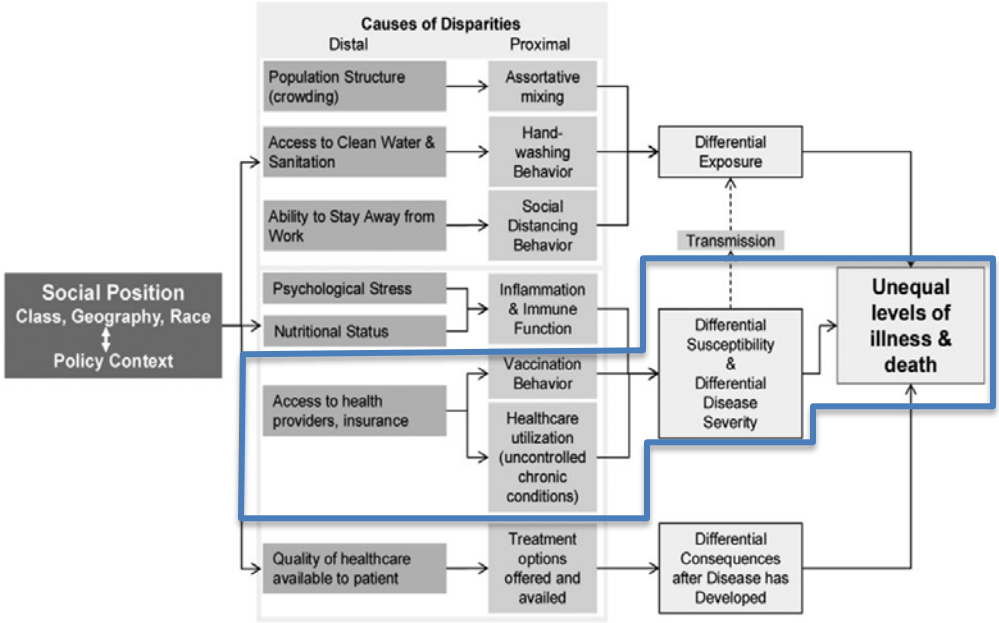


Figure 4-3: A mechanistic framework for countries to test the proximal (behavioural and biological) and distal (social and policy) risk factors that could lead to unequal levels of disease and death in an epidemic. Reprinted from Quinn, S. C., & Kumar, S., 2014. The publisher for this copyrighted material is Mary Ann Liebert, Inc. publishers.

Figure 4-3 (Quinn & Kumar, 2014) illustrates the pathways through which social inequalities can result in unequal levels of illness and death due to infectious diseases. As my study investigates the effectiveness of public health service delivery, specifically childhood immunizations, the disparity pathway I am assessing (outlined on Figure 4-3) involves the potential distal disparity in 'Access to health providers, insurance' some populations within urban centres may suffer over others. According to the framework, access disparities lead to differential vaccination behaviours, and thus differential susceptibilities to Measles, Mumps and Rubella. If this pathway is left unresolved, pockets of susceptibility and outbreaks can emerge, especially if susceptible populations are geographically clustered. Overall, this figure represents the basic rationale of the danger associated with inequalities of vaccination coverage.

4.4 Consolidated Framework for Implementation Research

The Consolidated Framework for Implementation Research (CFIR) was developed as a tool to detect evidence-based elements of successful program implementation and was used to guide the interview guide for the policy-based inquiry of this study. (Damschroder et. al, 2009) The framework is oriented as a menu of constructs to describe institutional characteristics, originally used in a comparative case-study design, to explain how and why some interventions were conducted in some cases and not in others. The constructs in the framework include Intervention Characteristics, Outer Setting, Inner Setting, Characteristics of Individuals, and Process.

Highly adaptable in its design, CFIR allows researchers to focus their efforts on detecting the most relevant information pertaining to program and policy interventions at multiple levels of an organization. "Intervention Characteristics" describe specific elements of the intervention, or interventions, in question; "Inner Setting" explores the internal characteristics of an organization as it pertains to program implementation; "Outer Setting" describes the extents of which the implementation of an intervention was influenced by external forces; and "Implementation Process" elements provide insight into the process through which interventions are incepted, to the evaluation of the outcomes. The framework also includes "Individuals involved", but as I took a purely institutional approach, I excluded the "Individuals involved" construct from my consideration.

4.5 WHO Tailoring Immunization Programmes Framework

In response to persistent low immunization coverage rates and the re-emergence of diseases like Measles, Rubella and Pertussis in the European regions, the W.H.O. European Region released the "The Guide to Tailoring Immunization Programmes (TIP)". The framework is detailed in its policy and programming process prescriptions. For the purposes of detecting the broad processes the case study cities conducted, I adopted the broadest constructs the WHO TIP framework explicitly utilizes to categorize their specific recommendations (WHO European Region, 2013). Details elucidated by *process-related* questions used from the Consolidated Framework for Implementation Research will populate this adaptation of the TIP

framework, giving insight into the policy-making process. Figure 4-4 is the policy cycle used in the WHO TIP framework that was utilized to guide the qualitative policy-based assessments of the case study cities:

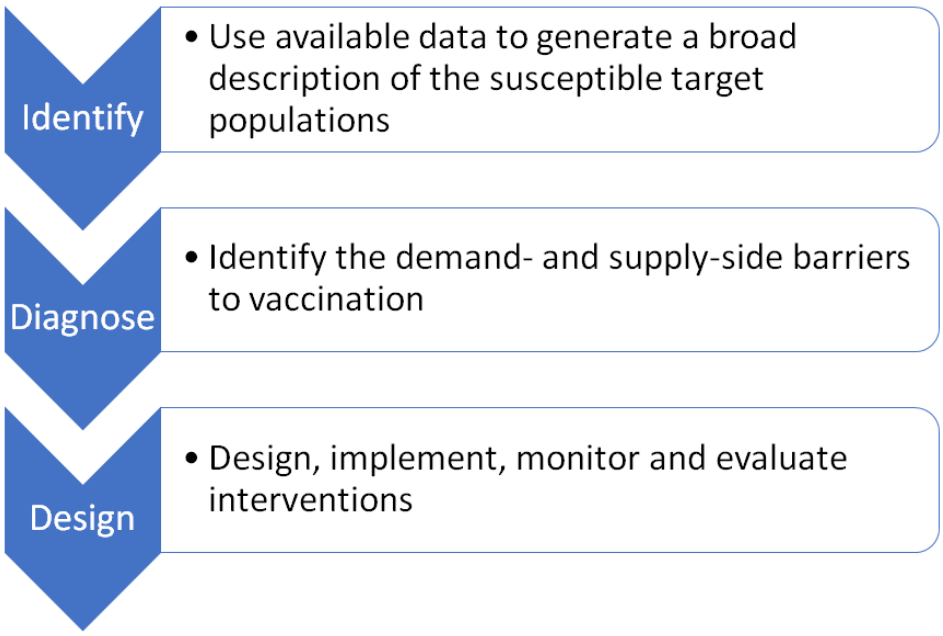


Figure 4-4: The World Health Organization Tailoring Immunization Programmes Policy Cycle, adapted from WHO European Region, 2013.

4.6 Combining the "What" and the "How": Study Framework

The following study framework is the culmination of perspectives and theories presented from the aforementioned frameworks from the literature. This study framework 'bounded' my qualitative and quantitative data such that the data across cases would be in similar forms, allowing me to better compare cases.

The "Public Health Practice" domain represents the institutional characteristics and the policy process associated with each of the public health programs. This section considers the "how" - PHSSR-based results detected using questions based on the Consolidated Framework for Implementation Research and the WHO TIP Policy Process Framework. The "Health-Inequalities-Over-Time One-Dose by Age 2 MMR Immunization Coverage Rates" are the outcomes detected by the quantitative analyses of 2009-2015 MMR coverage data. The "Childhood Immunization Interventions" section organizes the

interventions detected over the study period according to when they were deployed across the study timeline, and the length of intervention: whether the intervention was a one-off intervention or an ongoing intervention. This section answers the "what" - a PHIR-based inquiry about the actual interventions deployed and their characteristics. The results section of the dissertation reports each case within this framework to minimally organize the qualitative and quantitative results.

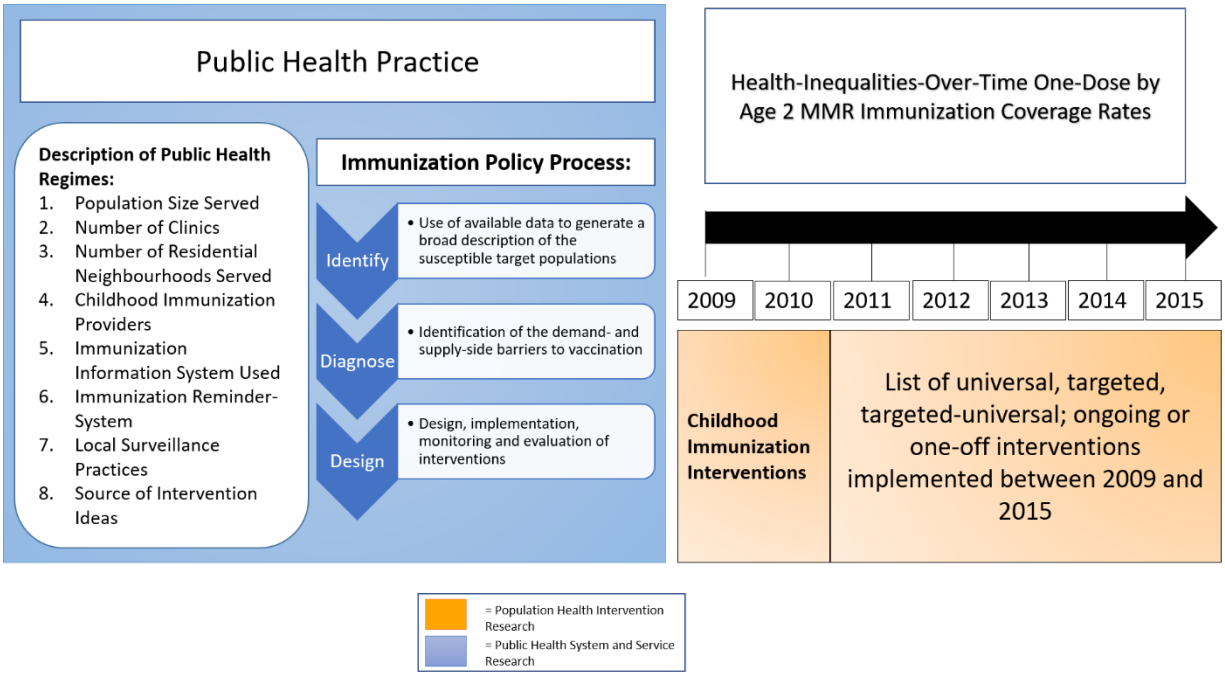


Figure 4-5: Study Framework

Chapter 5 : Methods

5.1 Comparative Case Study

A comparative case study analysis methodology was employed to answer the research questions. Case study research is defined as an "empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Gray, 2014, p.123). It adopts a naturalistic inquiry approach to research, where non-intrusive means of investigation are used to observe phenomenon in their own environments (Gray, 2014). Accounting for context is the cornerstone of case study research, and as a result, case studies themselves yield *context-dependent* knowledge that specifically addresses the nuances of the phenomenon in question. What should result from a well-conducted case study is a bounded, detailed account of the phenomenon. *Comparative* case study research furthermore analyzes the data across the cases "to test or develop a theoretical framework" (Dinour, Kwan, & Freudenberg, 2017). Each case is also treated as their own *natural experiment* over the study period, that is, as a phenomenon assessed in an "observational study, in which the researcher cannot control or withhold the allocation of an intervention to particular areas or communities, but where natural or predetermined variation in allocation occurs," a methodology often applied in health inequity research (Petticrew et al., 2005).

For this study, the individual "cases" were bound by place (geographical location) and time (2009-2015), each case representing a unit of measurement with its own unique contextual considerations. The central conceptual question of each case was the following: With respect to MMR immunization, what policy and coverage *trends* (time) occurred *here* (place) between 2009 and 2015? Both quantitative and qualitative contextual data *within* each case provided the answers to this question.

It is important to note that an assumption of this trend-based, natural experiment line of inquiry is that *changes* in yearly gaps of immunization coverage rates are indeed *influenced* by policy phenomena within each public health program, between 2009 and 2015. The epistemological underpinning coincided with a

critical realist interpretation of a natural experiment, such that *structures* (the only institution delivering immunizations, public health) and *conditions* (inner setting, outer setting, processes), through policy *mechanisms*, influence public health *effects/events* (Easton, 2010).

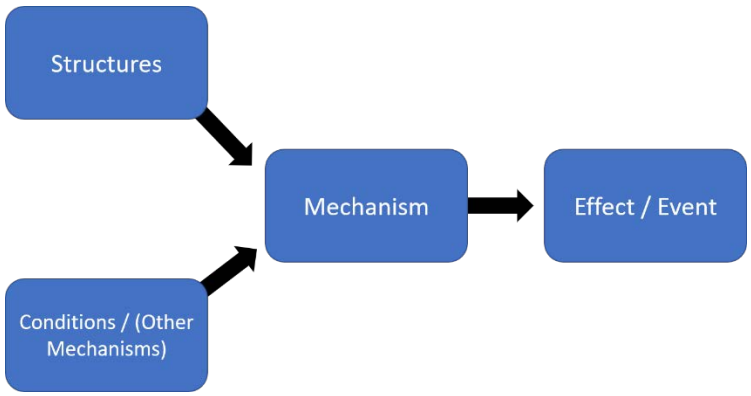


Figure 5-1: Epistemological assumptions of critical realism in case study research. Adapted from Easton, 2010.

Calgary, Edmonton, Saskatoon and Regina are each considered a "case", where quantitative and qualitative inquiries are used to unearth the epidemiological and policy contexts during the period in question (2009-2015), including some additional details into modern day public health practice in each case. The analysis is subsequently structured in within-case (over time) and between-case (between cities) formats.

The quantitative data was collected first, followed by the qualitative data. Each type of data was analyzed in parallel. No results from the quantitative analysis were shared with the interviewees before or during the interviews in order to assess the un-biased interviewee interpretations of their units' public health performance over the study period.

5.1 Recruitment

Contact information of senior-level medical health officers were obtained through the research partner organization, the Urban Public Health Network, representing the 13 largest urban public health regions across Canada. Representatives from all partner cities were sent recruitment forms outlining the specifications of the study. Though there was unanimous interest in participating, the feasibility for

extracting childhood immunization data from the respective data centres was highly variable across the country. In the end, the four prairie region cities were selected as these centres had the most comparable and feasible quantitative and policy-related data.

Ethics approval was granted through the University of Saskatchewan, the Saskatoon Health Region, the Regina Qu'Appelle Health Region, and Alberta Health Services to obtain six-digit postal code one-dose by age-two MMR immunization coverage for the years 2009-2015, inclusive. One-dose by age-two was selected because the first-dose immunization by age-two schedule is universal across all of Canada, while the second dose timelines vary across Canada. Ethics for the policy-based inquiry was exempt by the University of Saskatchewan Ethics Board as qualitative data obtained was work-related and deemed in the public sphere.

5.2 Quantitative Data Collection

One-dose by age-2 MMR immunization coverage rates were collected from each health region from all four cities, by postal code for the years 2009, 2010, 2011, 2012, 2013, 2014 and 2015. The postal code rates were restricted to those with the first 3-characters that Canada Post deems within each metropolitan area (Canada Post, 2014). This means data from greater metropolitan areas were not included in the study. These coverage rates by postal code were then aggregated up to neighborhood rates using 2015 neighborhood boundaries by a GIS analyst at Canadian Institutes of Health Information. Publicly-available neighborhood-level after-tax median income, % immigrant, % Aboriginal and % home ownership data were collected, and neighborhoods were assigned into quintiles for each indicator, for each year (five groups, each representing 20% of the population). All socioeconomic data were those collected firstly by the municipal governments themselves, from Statistics Canada, derived from the 2011 National Household Survey. It is important to note, subsequently, that an assumption of the quantitative analysis is that the socio-economic states of the neighbourhoods in 2011 represent the socio-economic states of those neighbourhoods between 2009 and 2015. The neighborhood immunization rates were then

linked to these quintiles and plotted for the years 2009, 2010, 2011, 2012, 2013, 2014, and 2015 to observe coverage rate trends by quintiles.

One-dose by age 2 MMR immunization coverage was chosen as the health outcome because as immunization is a central function of public health in Canada, and worldwide, it is an effective proxy for overall public health practice. One-dose, instead of two doses, was specifically chosen for the sake of comparability between cases; one-dose by age two is a consistent immunization guideline across all Canadian jurisdictions, while the timing of the second dose varies by province. Restricting it to age two also focuses the timing of the interventions in question to only include interventions that occur in the infant period. This improves the feasibility of the investigation by excluding interventions targeted at school-aged children, for example, that require distinct policy and programming considerations.

Income, aboriginal status, immigration status and % home ownership were chosen as the social determinants of health because these have consistently been shown to influence immunization status in Canada (Gilbert, Gilmour, Wilson, & Cantin, 2017), the United States (Glatman-Freedman & Nichols, 2012), Australia (McIntyre & Menzies, 2005) and Europe (France, Vanbiervliet, & Simonnot, 2014). Low income is often associated with poor outcomes across a multitude of indicators in Canada (Public Health Agency of Canada, 2018), also specifically, low immunization coverage rates in Alberta and Saskatchewan (Alberta Health, 2007; Diener, Abbas, & Granger, 2008; Sundquist, Dunlop, Wright, Findlater, & Gr, 2011). Nationally, poor health outcomes are also disproportionately reported in areas with higher proportions of indigenous populations. This is consistently shown across many health outcomes in Canada (Public Health Agency of Canada, 2018; UNICEF, 2009), and has been previously demonstrated specifically in Saskatoon and in Manitoba with regards to childhood immunization coverage (Lemstra et al., 2007; National Collaborating Centre for Determinants of Health, 2018).

Immigrant populations require specialized public health programming strategies due to some unique concerns among this population (Public Health Agency of Canada, 2011). Some immigrant populations have religious objections to immunization, as was the case with the Dutch-born populations whom were

associated with the 2013/2014 measles outbreak in Alberta; alternative health beliefs, as was the case with the Hutterite population during that same outbreak (Kulig et al., 2002) or are misinformed due to simple miscommunications between health professionals and immigrant parents (Kowal, Jardine, & Bubela, 2015). An investigation of coverage rates using an area-based measurement of %-immigrant populations in an urban setting may reveal MMR inequities among this population.

Home-ownership rate is a relatively under-researched indicator of socio-economic status with regards to childhood immunization coverage. One study shows that the areas with the lowest area-based rates of home-ownership, when included into a model of total deprivation, exhibited the lowest MMR coverage rates areas in England, especially in urban areas (Wright & Polack, 2006). My hypothesis is that because public health relies so heavily on staying in contact with parents through mail and phone outreach - to have parents return the clinics at regular intervals - areas with the highest relative proportion of frequently moving populations (renters) will consistently exhibit lower MMR coverage rates.

Figure 5-2 below depicts the data linkage process undertaken in this study to calculate the quintile-based coverage rate outcome measures:

Socioeconomic Data	Year	Source	Geography
After-tax Median Income	2011	Municipal Government, derived by 2011 NHS	Neighborhood
%-Immigrant Population	2011	Municipal Government, derived by 2011 NHS	Neighborhood
%-Aboriginal Population	2011	Municipal Government, derived by 2011 NHS	Neighborhood
%-Household Ownership	2011	Municipal Government, derived by 2011 NHS	Neighborhood

Childhood Immunization Data	Years	Source	Geography
One-Dose by Age 2	2009, 2010, 2011, 2012, 2013, 2014, 2015	Calgary: Alberta Health Edmonton: Alberta Health Saskatoon: Saskatoon Health Region Regina: Regina Qu'Appelle Health Region	Postal code, aggregated to Neighborhood

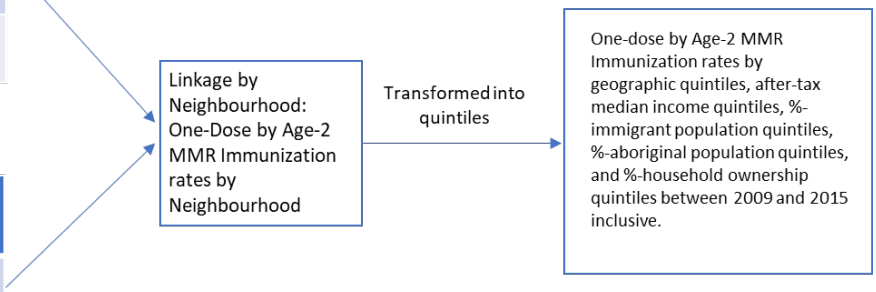


Figure 5-2: Quantitative data transformation diagram

5.3 Quantitative Data Analysis

Rates are calculated by dividing the number of two-year old children immunized in a neighbourhood in a given year by the total number of two-year old children in that neighbourhood in a given year; the numerators collected from public health units and the denominators which are derived from provincial government population registries for both Saskatchewan and Alberta. The MMR immunization coverage data was stratified in five different quintile configurations. To create the quintiles in each year, the neighborhood coverage data were ranked by each stratifier. The total population of neighborhoods are then divided such that there are five groups, each representing 20% of the total population. Then within each quintile, the total number of children immunized in each quintile is divided by the total number of two-year old children in each quintile, yielding a coverage rate for each quintile. For the years 2009-2015, one-dose by age-two MMR coverage rates quintiles were constructed based on the following **stratifiers**:

1. *Coverage rates by neighbourhood:* **Quintile 1** represents the neighbourhoods that contain the 20% of the population with the **lowest MMR coverage rates** and **quintile 5** represents the neighbourhoods that contain the 20% population with the **highest MMR coverage rates.**

2. *Income:* **Quintile 1** represents the MMR coverage rates of the 20% of the population who live in neighbourhoods with the **lowest after-tax median income** and **quintile 5** represents the MMR coverage rates of the 20% of the population who live in neighbourhoods with the **highest after-tax median income**.

3. *Proportion of those who identify as Aboriginal:* **Quintile 1** represents the MMR coverage rates of the 20% of the population who live in neighbourhoods with the **lowest proportions** Aboriginal citizens and **quintile 5** represents the MMR coverage rates of the 20% of the population who live in neighbourhoods with the **highest proportions** of Aboriginal citizens.

4. *Proportion of those who identify as immigrants to Canada:* **Quintile 1** represents the MMR coverage rates of the 20% of the population who live in neighbourhoods with the **lowest proportions** immigrant citizens and **quintile 5** represents the MMR coverage rates of the 20% of the population who live in neighbourhoods with the **highest proportions** of immigrant citizens.

5. *Proportion of those who report home-ownership:* **Quintile 1** represents the MMR coverage rates of the 20% of the population who live in neighbourhoods with the **lowest proportions** of those who report home ownership and **quintile 5** represents the MMR coverage rates of the 20% of the population who live in neighbourhoods with the **highest proportions** of those who report home ownership.

Rate ratios and 95% confidence intervals (p=0.05) were then calculated to assess if there is a statistically significant different coverage rate between the highest and lowest quintiles. The confidence intervals were calculated using MedCalc Software “Comparison of two rates” functionality (MedCalc, 2018).

The Quintile 1/Quintile 5 placement is reversed when calculating the confidence intervals for the %-Aboriginal and %-Immigrant stratifiers as the risks of inequities is elevated as % of those populations

increased. This contrasts with the coverage rates, income and %-homeownership stratifiers, where the risks of inequities decrease as coverage rates, income and %-homeownership increases.

A rate ratio of >1 indicates that the group with the highest exposure to a risk variable has an increased likelihood of exhibiting a given outcome. A rate ratio of one indicates that the groups are equally as likely to exhibit an outcome regardless of exposure. A rate ratio <1 indicates that the group with the highest exposure to a variable has a decreased likelihood of exhibiting a given outcome. If the 95% confidence interval (p=0.05) include one in its range, the difference between the two proportions is considered not statistically significant.

5.3 Qualitative Data Collection

5.3.1 Interviews

Upon completing the initial recruitment process, of the four participating cities, senior-level public health professionals were recruited through a snowball-strategy where UPHN-member medical health officers recruited themselves to be interviewed and recommended the appropriate manager to contact. The managers were then sent a letter outlining the study where they were given the opportunity to participate or not. Upon replying with interest, each participant scheduled a phone or in-person interview and gave oral consent at the beginning of each interview to be recorded. Calgary, Edmonton, Saskatoon and Regina public health professionals (total n=12; Table 1) were interviewed in 2016 about the historical and present-day childhood public health immunization programs with which they were/are associated. (Appendix: Qualitative Interview Guide) These interviews were conducted in parallel with the quantitative data analysis so participants we not aware of the quantitative results. This was done to ensure participants reported an unbiased account of their own unit's immunization coverage performance over the study period. All interviews were recorded and transcribed.

	Calgary	Edmonton	Saskatoon	Regina	Total
Number of interview subjects	2 individuals: Both Calgary-specific professionals	4 individuals: 2 Edmonton-specific professionals	3 individuals: All 3 were Saskatoon-specific professionals	3 individuals: All 3 were Regina-specific professionals	**12 public health professionals**
	2 provincial representatives				

Table 5-1: Number and location of interviews for qualitative data

5.3.2 Documents

Relevant documents pertaining to public health programming were retrieved from the internet as well as from the participants directly if they were deemed appropriate to be publicly available. Annual reports of the Ministries and the health regions between 2008 and 2016 provided the highest-level policy-related information for the time period in question. The Public Health departmental websites within the regions were then scrutinized for pertinent documents, including their own annual or sub-annual reports, if available. Childhood immunization-related grey literature and peer-reviewed literature were retrieved if the keywords “Saskatoon”, “Regina”, “Calgary”, “Edmonton”, “Saskatchewan” and/or “Alberta”, were included in the documents.

5.4 Qualitative Data Analysis

5.4.1 Interview Data Analysis

Interview data were transcribed and input into NVIVO 10 Software (QSR International, n.d.) with which thematic analysis (TA) was conducted. Thematic analysis is described as “an analytic construction of: (a) codes, (b) themes in qualitative verbal expressions; and (c) patterns of recurrence, evaluation of associations within these themes” (Herzog, Handke, & Hitters, 2018, p.2) in order to minimally organize rich and complex textual data. TA is conducted as an exploratory assessment where the researcher familiarizes oneself with the interview data, categorize passages according to themes, and extracts representative data to be featured in the final analysis (Braun & Clarke, 2006). According to Braun and

Clarke (2006), thematic analysis can be an *inductive*, bottom-up processes where the themes emerge from the text itself rather than necessarily being correlated to the interview questions, similar to the grounded-theory approach of qualitative analysis. Thematic analysis can also be a *theoretical* endeavour - a more analytic process involving a less rich, but more directed and detailed explanation of the data using an a-priori theoretical framework to guide the analysis. This study used the latter approach by deriving themes from the initial study theoretical framework (See Appendix: Qualitative Interview Guide) to guide the thematic analysis process. Policy-making process-related data was uncovered using the "Internal", "External" and "Process" constructs and code-book from the Consolidated Framework for Implementation Research (Damschroder et al, 2009). Data was then mapped onto the WHO TIP framework for each case city to explicate their policy-making process.

The interview data was transcribed into NVIVO 10 and content was themed using the domains of the interview framework. Appendix: Qualitative Interview Guide explicates the framework used to organize the questions that were asked of the participants (interview questions are included in the Appendix). It was this first iteration of the study framework that informed the themes ("nodes" in NVIVO). When passages in the interview data resonated with the themes (Table 2), they would be placed into the thematic nodes in the software. The nodes that contained aggregated passages were then compared across cases.

Upon comparisons it was apparent that not all the cases yielded the same amount of node data - i.e. some interviews contained more detailed information than others. The final study framework represents the minimally-common amount of themes that were extracted from the cases; this parsimonious final study framework (Figure 4-5) was deduced to maximize the comparability of the data. A step-by-step guide to the initial framework, the evidence behind each thematic construct and the rationale on how the interview questions were informed by this framework is attached as an Appendix.

Code category	Code	Description
Public Health Capacity	Population Size Served	# of people served by the public health unit
	Number of clinics	# of physical immunization locations

	Who are the providers	Which health professionals deliver immunizations
	Local surveillance practices	What types immunization information systems used and how is the data collected
Immunization policy process	Identify	How is immunization data generated
	Diagnose	How are barriers to immunization assessed
	Design	How are programs developed, implemented and monitored
Innovation Characteristics	Innovation Source	Perception of key stakeholders about whether the innovation is externally or internally developed.
	Evidence Strength & Quality	Stakeholders' perceptions of the quality and validity of evidence supporting the belief that the innovation will have desired outcomes.
	Cost	Costs of the innovation and costs associated with implementing the innovation including investment, supply, and opportunity costs.
Outer Setting	Needs & Resources of Those Served by the Organization	The extent to which the needs of those served by the organization (e.g., patients), as well as barriers and facilitators to meet those needs, are accurately known and prioritized by the organization.
	Cosmopolitanism	The degree to which an organization is networked with other external organizations.
	Peer Pressure	Mimetic or competitive pressure to implement an innovation, typically because most or other key peer or competing organizations have already implemented or are in a bid for a competitive edge.
	External Policy & Incentive	A broad construct that includes external strategies to spread innovations including policy and regulations (governmental or other central entity), external mandates, recommendations and guidelines, pay-for-performance, collaboratives, and public or benchmark reporting.
Inner Setting	Structural Characteristics	The social architecture, age, maturity, and size of an organization.
	Networks & Communications	The nature and quality of webs of social networks, and the nature and quality of formal and informal communications within an organization.
	Culture	Norms, values, and basic assumptions of a given organization.

	Implementation Climate	The absorptive capacity for change, shared receptivity of involved individuals to an innovation, and the extent to which use of that innovation will be rewarded, supported, and expected within their organization.
	Readiness for Implementation	Tangible and immediate indicators of organizational commitment to its decision to implement an innovation.
Process	Planning	The degree to which a scheme or method of behavior and tasks for implementing an innovation are developed in advance, and the quality of those schemes or methods.
	Engaging	Attracting and involving appropriate individuals in the implementation and use of the innovation through a combined strategy of social marketing, education, role modeling, training, and other similar activities.
	Executing	Carrying out or accomplishing the implementation according to plan.
	Reflecting & Evaluating	Quantitative and qualitative feedback about the progress and quality of implementation accompanied with regular personal and team debriefing about progress and experience.

Table 5-2: Qualitative Interview Code Table[4]

5.4.2 Document Content Analysis

Document content analysis is an iterative process of superficial examination and interpretation of textual documents. This analysis is appropriate for detecting specific elements of textual documents for exploratory use, quantifying qualitative data into units of analysis (Braun & Clarke, 2006). The purpose of using this method in this study was to specifically detect, in often complex multi-subject documents, where and in what manner concepts related to childhood immunization are specifically mentioned. Documents analysis was conducted on all Alberta Health (2008-2016), Alberta Health Services (2008-2016), Saskatchewan Ministry of Health (2008-2016), Saskatoon Health Region (2008-2016) and Regina

[4] All code descriptions in the "Intervention Characteristics", "Outer Setting", "Inner Setting", and "Process" are all verbatim from the CFIR codebook distributed by CFIR Research Team-Centre for Clinical Management Research (2019)

Qu'Appelle Health Region (2008-2016) annual reports, and all other reports publicly-available or provided by each interviewee regarding childhood immunization during the period of 2008-2016. The analysis involved text-based search of all documents for the terms "equity", "equality", "vulnerable", "child", "childhood", "immunization", "measles", and "MMR"; and extraction of content that involved childhood immunization programming and equity-based policies/programs. The documents provided both contextual quantitative (past coverage rates) and qualitative (policy/programming content) data on the four case studies. Relevant data were extracted and transcribed into field notes and policy-timelines where applicable. These data were then combined with the interview data to yield the final synthesis of the cases shown in the results figures.

Keywords: "equity"; "equality"; "vulnerable"; "child"; "childhood"; "immunization"; "measles"; "MMR"	
Inclusion	**Exclusion**
- Content regarding early* childhood immunization policy or epidemiology relevant to the period between 2009 and 2015* (included extended searches on each end of study period if information was relevant to policy context). - Mentions of MMR specifically - Information specific to Calgary, Edmonton, Saskatoon and Regina	- Content regarding childhood immunization after 2 years of age, unless relevant to overall MMR vaccination policies - Non-MMR immunizations (largely influenza).

Table 5-3: Document analysis criteria

Calgary	Edmonton	Regina	Saskatoon
-Alberta Health Annual Reports (2008-2016). -Alberta Health Services Annual Reports (2008-2016). - Calgary Zone News 2009-2015 - Alberta Immunization Strategy 2007-2017	-Alberta Health Annual Reports (2008-2016). -Alberta Health Services Annual Reports (2008-2016). -Edmonton Zone News 2009-2015 - Alberta Immunization Strategy 2007-2017	- Regina Qu'Appelle Health Region Annual Reports (2008-2016). - Regina Qu'Appelle Health Region E-link newsletter (2009-2015). - Regina Qu'Appelle Health Region Annual Community Reports (2009-2015). - Regina Qu'Appelle Health Region Health News (2009-2015). - Saskatchewan Immunization Manual	- Saskatoon Health Region Annual Reports (2008-2016). - "Health For All" documentation (Series 2, 2014). - Saskatchewan Immunization Manual - "Population and Public Health: Early Years Health and Development Strategy (2013-2016)." - "Healthy families, healthy communities, healthy children: a report of the Chief Medical Health Officer on the health status and development of young children in Saskatoon Health Region." - "Towards Equity in Immunization: The Immunization Reminders Project" - Saskatchewan Ministry of Health Annual Reports (2008-2015).

Table 5-4: Documents analyzed by case city

5.6 Summary:

The following table provides a summary of the methodology of this study:

	First phase collection	Second phase collection	
	Simultaneous Analysis		
	Quantitative Health-Inequalities-Over-Time Analysis (2009-2015).	Interviews with public health professionals	Document Analysis
Which urban public health units have reduced MMR coverage inequities in the Canadian Prairies?	Obtained comparable coverage data from four prairie urban centres and stratified data according to geography, neighbourhood income, neighbourhood %-Aboriginal proportion, neighbourhood %-immigrant proportion, and neighbourhood %-home ownership proportion	Assessed interviews for equity-based childhood immunization policy-making narratives	Assessed past documents for equity-based data regarding childhood immunization
Which interventions and/or policies have worked to reduce inequities and where?	Matched health-inequalities-over-time **outcome** measurements with quantitative policy **content** data	- Analyzes interview data for **process**-related details into equity-based childhood immunization policy-making - Utilized interview data to explicate detailed **content** of interventions - Placed interventions that were mentioned by interviewees in a timeline to match with the quantitative data	- Assessed past reports and literature for equity-based policy and programming regarding childhood immunization - Utilized literature to explicate detailed **content** of interventions

Table 5-5: Summary of study methodology

Chapter 6 : Results

The results are presented by case province and by case city. Firstly, the provincial descriptions include *contextual* information about public health governance and any provincial activities regarding childhood immunization, including province-wide interventions that may have taken place, around or during the study period.

The case city results are introduced through a completed framework representation of the results. The left boxes in the results framework summarize basic descriptive elements of a given cities' modern public health practice and outline details of the WHO TIP cycle elements apparent in their policy-making processes. The graphs on the right show the coverage rate trajectories for quintiles one and five, for each stratifier, each dyad represented by its own colour: Shades of orange for coverage quintiles; Shades of green for income-based quintiles; Shades of blue for %-Aboriginal population quintiles; Shades of black for %-Homeownership quintiles; and Shades of peach for %-Immigrant population quintiles. Below the graphs are the interventions implemented over the time period, separated into two categories: *Ongoing initiatives* that began at some point before or during that intervention, and persist until at least 2015; or those that were *one-off initiative*s with well-defined start and end dates. Each intervention has a bracketed label, with the first character representing the city (S for Saskatoon, for example), and the second character being numerical. These labels are used to bridge the framework to the textual result descriptions presented and provide insight to the reader where specific policy and programming activities mentioned in the textual descriptions fit into the broader policy timelines (look for **bolded** labels in the textual descriptions to match the framework).

The subsequent textual results sections provide regional contextual descriptions; insights into their modern public health practice regarding childhood immunizations, including those that map onto the aforementioned WHO TIP policy process framework; and the interventions implemented around or during the study period. Note that if *cities* are included in any aforementioned *provincial* interventions, their involvement is also reported in the case city results sections.

Results depicting the individual stratifier outcomes graphs reporting one-dose by age-two MMR immunization coverage rate graphs follow the textual descriptions for the case study city, displaying the overall rates between 2009 and 2015, and the first and fifth quintiles for each stratifier, as well as a table for each graph showing the rate ratios and 95% confidence intervals of the rate ratios for the years between 2009 and 2015, inclusive. The graphs are displayed in the following order: Overall city-wide coverage rates; Quintiles of neighbourhood coverage rates; quintiles of neighbourhood income coverage rates; quintiles of neighbourhood %-aboriginal population coverage rates; quintiles of neighbourhood %-immigrant population coverage rates; and quintiles of neighbourhood %-home-ownership coverage rates. Note that these are *the same rates that are displayed in the framework*, but here they are presented individually.

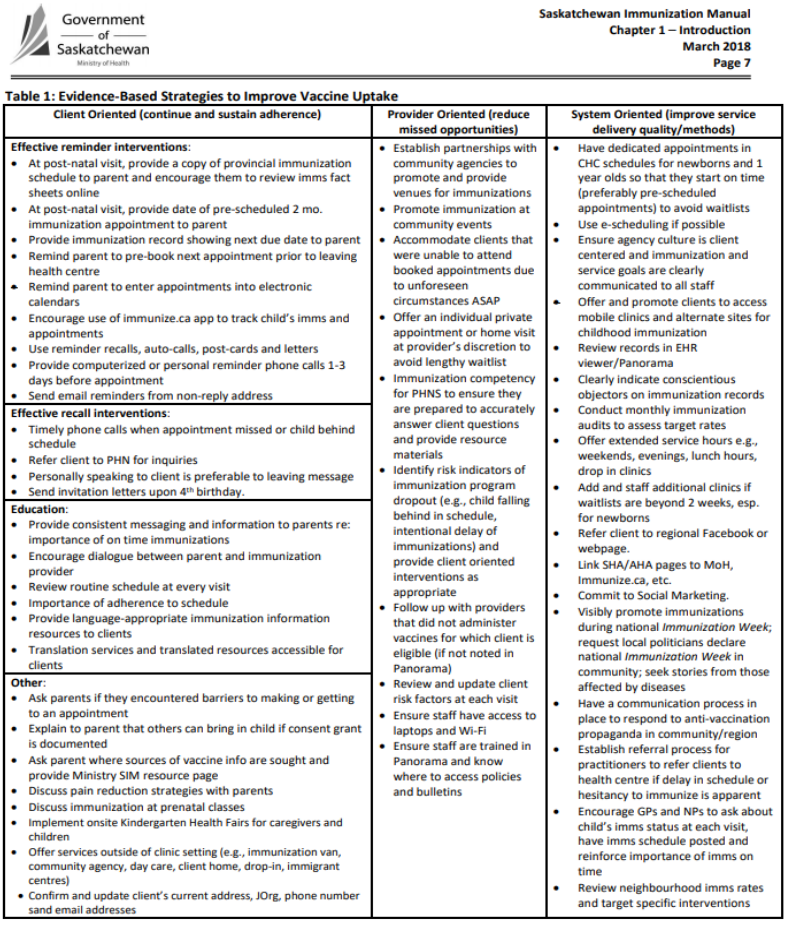
6.1 Saskatchewan

6.1.1 Context over time

In Saskatchewan over the study period, health care and public health services were delivered by twelve autonomous regional bodies under the guidance of the provincial Ministry of Health (Government of Saskatchewan, 2017). In this respect, and in contrast to Alberta, the Saskatchewan health system was relatively stable in terms of governance over the study period (2009-2015). As of 2018, however, the province had migrated to an Albertan-style single health authority, though implementation of new governance structures is still ongoing (Abrametz, Bragg, & Kendel, 2016).

Public health guidelines and targets are created, and a provincial immunization registry is maintained by the Saskatchewan Ministry of Health. Public health practice is operationalized locally by twelve local health regions. Targets and goals are set by the province, and regional public health offices work with their own medical officers of health and population health branches to adapt locally-developed practices. The province provides the “Saskatchewan Immunization Manual” that set all clinical guidelines that the regions are accountable to. The manual also contains a table with strategies to increase immunization

uptake divided into *Client*, *Provider*, and *System* oriented strategies (Government of Saskatchewan, 2016).



Government of Saskatchewan
Ministry of Health

Table 1: Evidence-Based Strategies to Improve Vaccine Uptake

Client Oriented (continue and sustain adherence)	Provider Oriented (reduce missed opportunities)	System Oriented (improve service delivery quality/methods)
Effective reminder interventions: • At post-natal visit, provide a copy of provincial immunization schedule to parent and encourage them to review imms fact sheets online • At post-natal visit, provide date of pre-scheduled 2 mo. immunization appointment to parent • Provide immunization record showing next due date to parent • Remind parent to pre-book next appointment prior to leaving health centre • Remind parent to enter appointments into electronic calendars • Encourage use of immunize.ca app to track child's imms and appointments • Use reminder recalls, auto-calls, post-cards and letters • Provide computerized or personal reminder phone calls 1-3 days before appointment • Send email reminders from non-reply address	• Establish partnerships with community agencies to promote and provide venues for immunizations • Promote immunization at community events • Accommodate clients that were unable to attend booked appointments due to unforeseen circumstances ASAP • Offer an individual private appointment or home visit at provider's discretion to avoid lengthy waitlist • Immunization competency for PHNS to ensure they are prepared to accurately answer client questions and provide resource materials • Identify risk indicators of immunization program dropout (e.g., child falling behind in schedule, intentional delay of immunizations) and provide client oriented interventions as appropriate • Follow up with providers that did not administer vaccines for which client is eligible (if not noted in Panorama) • Review and update client risk factors at each visit • Ensure staff have access to laptops and Wi-Fi • Ensure staff are trained in Panorama and know where to access policies and bulletins	• Have dedicated appointments in CHC schedules for newborns and 1 year olds so that they start on time (preferably pre-scheduled appointments) to avoid waitlists • Use e-scheduling if possible • Ensure agency culture is client centered and immunization and service goals are clearly communicated to all staff • Offer and promote clients to access mobile clinics and alternate sites for childhood immunization • Review records in EHR viewer/Panorama • Clearly indicate conscientious objectors on immunization records • Conduct monthly immunization audits to assess target rates • Offer extended service hours e.g., weekends, evenings, lunch hours, drop in clinics • Add and staff additional clinics if waitlists are beyond 2 weeks, esp. for newborns • Refer client to regional Facebook or webpage. • Link SHA/AHA pages to MoH, Immunize.ca, etc. • Commit to Social Marketing. • Visibly promote immunizations during national *Immunization Week*; request local politicians declare national *Immunization Week* in community; seek stories from those affected by diseases • Have a communication process in place to respond to anti-vaccination propaganda in community/region • Establish referral process for practitioners to refer clients to health centre if delay in schedule or hesitancy to immunize is apparent • Encourage GPs and NPs to ask about child's imms status at each visit, have imms schedule posted and reinforce importance of imms on time • Review neighbourhood imms rates and target specific interventions
Education: • Provide consistent messaging and information to parents re: importance of on time immunizations • Encourage dialogue between parent and immunization provider • Review routine schedule at every visit • Importance of adherence to schedule • Provide language-appropriate immunization information resources to clients • Translation services and translated resources accessible for clients		
Other: • Ask parents if they encountered barriers to making or getting to an appointment • Explain to parent that others can bring in child if consent grant is documented • Ask parent where sources of vaccine info are sought and provide Ministry SIM resource page • Discuss pain reduction strategies with parents • Discuss immunization at prenatal classes • Implement onsite Kindergarten Health Fairs for caregivers and children • Offer services outside of clinic setting (e.g., immunization van, community agency, day care, client home, drop-in, immigrant centres) • Confirm and update client's current address, JOrg, phone number sand email addresses		

Figure 6-1: Evidence-based strategies to improve vaccine uptake. Reprinted from Government of Saskatchewan, 2016.

Each of the twelve regions have unique public health human resources and practices. For example, it was noted during the study that though the same immunization data surveillance system (IBM, 2009) is utilized by Saskatoon and Regina, each region had their own method with which the data is cleaned. This yields inconsistent rates reported between the regions and the province.

It is also important to note that during the study period (2009-2015), the Ministry of Health deployed a quality improvement initiative across the entire provincial health system (including public health), called Lean. Originating from the manufacturing management literature, Lean is a "multi-faceted, patient-

centred approach to manage and improve both quality and efficiency" (Rotter et al., 2014, p.5), emphasizing the use of continuous improvement activities to remove wasteful processes within any given health care setting. The implementation of Lean was a massive undertaking, unprecedented in scale where, as of 2016, evaluators "found no evidence of any system-wide attempt to apply Lean elsewhere in the world" (Rotter et al., 2014, p.47). As of 2018, studies indicate poor perceptions of Lean implementation among the affected health care providers (Goodridge et al., 2018).

6.2 Saskatoon

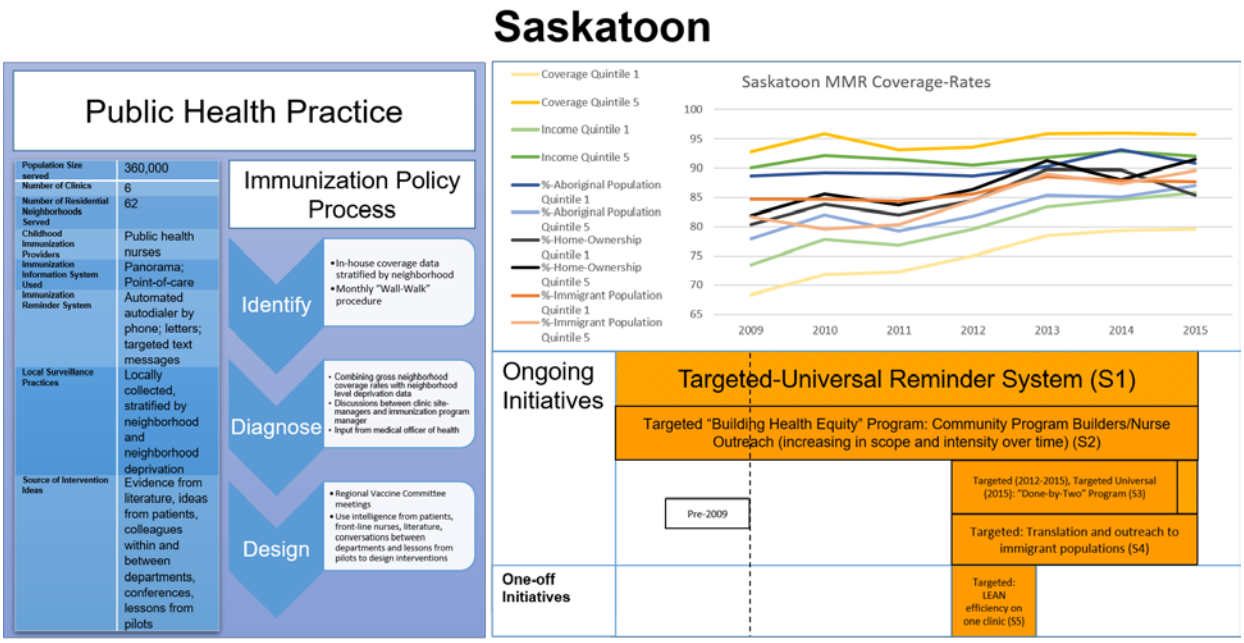


Figure 6-2: Saskatoon results summary

6.2.1 Public Health Practice

The Saskatoon Health Region serves 360,000 residents covering more than 100 cities, towns, villages, rural municipalities and First Nations communities (Saskatoon Health Region, 2018d). Childhood immunizations are delivered in six child health clinics, plus three additional drop-in locations, serving 62 residential neighbourhoods (Saskatoon Health Region, 2018b). In order to manage the increasing number of vaccines to distribute over the last decade, in 2014, immunization responsibilities were taken out of the Communicable Disease Control program and given its own program, with one dedicated Medical Health Officer as a clinical lead.

The majority of childhood patients go to child health clinics to get immunized, where 20 to 45 minute appointments are made with a public health nurse when the child is 2, 4, 6, 12 and 18 months, and 4 years of age. Additional services offered by public health nurses include: “parental support and health

information on variety of topics including: infant growth and development; feeding and nutrition; oral health; safety; exposure to second hand smoke" (Saskatoon Health Region, 2018d).

The immunization manager and the public health analyst at the SHR Public Health Observatory are central to the baseline processes that occur day-to-day. They, along with the clinical dyad Medical Health Officer, conduct monthly "wall-walks", observing neighbourhood immunization rates and wait-time graphical trends collated by the analyst and physically posted on the walls of the office. The epidemiologist uses mapping software to report coverage rates on an ongoing basis. There are built-in socioeconomic considerations that apply to all neighborhoods they analyse, including a measure of relative 'neighbourhood deprivation', that determine the specific elements of the interventions needed for a given neighbourhood (Saskatoon interview #2). The immunization manager is also in direct contact with frontline public health staff: In Saskatoon's case, these are public health nurses and community program builders, who are non-healthcare employees tasked with building relationships with families in especially low-coverage rate neighbourhoods. The immunization manager also works laterally, across departments involved with immunizations to assess emerging concerns (Saskatoon interview #2).

When coverage rates reach a visual threshold on the wall-walk graphs, or concerns are brought forward from front-line staff, public health leadership institute "Corrective Actions A3's" – a LEAN procedure first implemented in 2011-2012 – that create plans to improve coverage rates, utilizing a 'casual hours' budget available to the immunization manager should there be a need for extra services. Ideas for interventions reportedly came from meetings across departments, front-line professionals, evidence from the literature, lessons from pilots and from clients themselves who, when engaged both one-on-one and in formal focus groups, would report barriers to public health staff.

6.2.2 Interventions: Universal and Targeted Interventions

6.2.2.1 Universal

By 2009, a universal reminder program **(S1)** was in place involving five phone calls and a mail-out letter to parents with incompletely immunized children aged 14 and 20 months. A 2010 evaluation showed that

there was an increase in core neighbourhoods (41.5% – 56.7%) and non-core neighbourhoods (64.9% - 77.6%) MMR coverage rates, with a decrease in the disparities (using core neighbourhoods as reference: Rate ratio of 0.64 to 0.73) between 2003 and 2009 due to this intervention (Cushon et al., 2012). Since then, it was reported by interviewees that the recall-reminder system has undergone iterative changes to stay universal, but also become more targeted, in its reach (see "Targeted-Universal section" section). The system was automated through the use of an autodialer in 2012, eliminating the need to use the nursing or clerk human resource time and monies to manually make reminder phone calls.

6.2.2.2 Targeted

The years 2006 to 2008 were pivotal in the development of an equity-based ethos for the Saskatoon Health Region with the report *Health Disparity in Saskatoon: Analysis to Intervention* (Lemstra & Neudorf, 2008). Massive health inequities across numerous conditions triggered a reaction that reverberated to the top of the Saskatoon Health Region management. Many subsequent organizational changes occurred across the region. Regarding immunization, equity-related work has been explicit and sustained for the past ten years. In 2006, a study was conducted to determine attitudes towards immunizations, and to assess which options parents used to keep children up-to-date. The following summarizes the finding of their study:

> "The survey identified that incomplete immunization in SHR is primarily associated with low-income; however, single parenthood, cultural status and differences in beliefs also contributed to incomplete coverage rates. The solutions that were most strongly supported by parents to ensure more complete coverage rates were: reminder letters, reminder phone calls, reminders from other health care practitioners, flexible walk-in clinics, and extended evening and weekend clinic hours" (Saskatoon Health Region, 2011, p. 7-8).

The immediate result of this early equity work was the formation of the Building Health Equity program **(S2)** in Population and Public Health:

> "The Building Health Equity program was formed in 2007 to address health equity issues within the core-neighbourhoods of Saskatoon. We provide services which include: Child Health Clinic Services, Postnatal home visits, Breastfeeding supports, Housing issues, and we partner with various agencies and schools in the area.
>
> We have an interdisciplinary team made up of:
>
> Public Health Nurses, Community Program Builders, a Public Health Inspector, Program Manager, Office Administrative Assistant and a Community Dietitian" (Saskatoon Health Region, 2018a).

This program is located in, and specifically targets, inner-city low-income communities. The BHE front-line professionals assess and collect information regarding barriers clients face and report them up to management throughout the Population and Public Health department.

Regarding the study period, 2011 to 2013 saw the initiation of particularly intensive improvement of overall immunization programming at the Saskatoon Health Region. In 2011, letters were sent to all children behind on immunizations, and phone calls were made immediately prior to appointments. Parents in low-income neighbourhoods were targeted using text message reminders and provided grocery card incentives **(S1)**. Public health also worked with schools (starting in 2011) and the Open Door Society (starting in 2010) to connect with newcomer families, where they also brought in on-demand translation services in 2013 **(S4)** (Saskatoon Health Region, 2014, 2015, 2017). In 2012, the Saskatoon Health Region also launched an initiative – "Done-by-Two" **(S3)** – to increase immunization coverage rates by targeting under-immunized children in low-coverage neighbourhoods between 20 and 24 months of age. A major element of this initiative was intensifying the integration of Community Program Builders (CPB's) **(S2)** to supplement the continuously refining - and by 2012, automated - recall-reminder system (Saskatoon Health Region, 2013, 2014). Community Program Builders are non-healthcare professional workers in the community that assist families in areas with under-immunized children and were introduced into the Building Health Equity Program in 2007. The CPB's are embedded in the

communities, build relationships with families and assist in making appointments and transportation, as well as join clients to their appointments. They report directly to the manager of immunizations where they can provide feedback on public health services. Since 2007, the number of CPB's has increased from one to three. The 2012-2013 SHR Annual Report recognizes the promising one-year gains of immunization rates among 2-year-olds (77.2% 2-dose MMR coverage rate in March 2012 to 78.9% 2-dose MMR coverage rate in March 2013), of which they attribute to the "Done-by-Two" campaign. In 2015, "Done-by-Two" was expanded to a universal program **(S3)**, covering all neighbourhoods in Saskatoon (Saskatoon Health Region, 2016).

In 2013, it is reported that the aforementioned LEAN program **(S5)** was initiated into one clinic to improve efficiencies. Drop-in clinics were expanded, services were co-located with an inner-city grocery store, and CBP/Nurse dyads initiated making targeted home visits to immunize (all intensifying S2 programming). Real-time interpreter services were also purchased to help with newcomer public health appointments (Saskatoon Health Region, 2014).

6.2.2.3 Universal-Targeted

Findings from the study led to a 2007 Canadian Institutes of Health Research and Saskatoon Tribal Council funded intervention project titled "Disparity of Childhood Immunization Coverage by Neighbourhood Socioeconomic Status", specifically involving an immunization reminders project **(S1)**. A strategy involving up to five phone calls, then a letter, and a home-visit, was mobilized for children living in six core neighbourhoods. Since this intervention, the reminder system has undergone continuous improvements to reach both parents from across the city as a whole, and to target low-coverage neighbourhoods.

Since then, the immunization reminder protocol in Saskatoon has accounted for neighbourhood socioeconomic status by adapting the medium of reminder outreach, based on need. For example, it is reported that between 2008 and at least 2011 (reported in 2011) non-core neighbourhood children only received immunization reminder letters, while the core neighbourhood children whom existed on a

geographically-specific database received a phone call, letters and home visits from the Community Program Builders (Saskatoon Health Region, 2011). Subsequently, in 2014, the Community Program Builder mandate grew to serve all neighbourhoods. Thus, the overall reminder program **started as a targeted (CIHR-funded pilot), followed by a targeted-universal (Integration of the Building Health Equity program and Community Program Builders), and then became more universal (expanding the reach of the CPB's)**, utilizing elements from the successes from the targeted approach, to reach the most citizens possible.

6.2.3 Outcomes

Saskatoon experienced rising overall one-dose MMR coverage rates overall between 2009 and 2015 (83.38% to 89.96%) and persistent area-based geographic MMR coverage rate inequities, although the gap between the highest and lowest coverage rate neighbourhood decreased across the study period (RR range= 1.20 - 1.36; Rates in bottom quintile = ~69% to ~80%; Rates in top quintile = ~93% to ~96%). When adding the area-based social determinants of health indicators to the analysis, the data shows clear coverage gap-reducing trends based on neighborhood income (RR range= 1.22 in 2009 to 1.07 in 2015; Rates in bottom quintile = ~75% to ~86%; Rates in top quintile = ~90% to ~93%) and %-aboriginal population (RR range= 1.14 in 2009 to 1.04 in 2015; Rates in lowest %-aboriginal population quintile = ~78% to ~86%; Rates in highest %-aboriginal population quintile = ~89% to ~93%). Coverage rates gaps based on *neighbourhood income* showed the highest statistically significant change: The difference in coverage rates between the highest and lower income neighbourhoods went from statistically significant in 2009 to statistically insignificant starting and 2012, onward. All quintiles across all stratifiers increased absolute coverage rates over the study period.

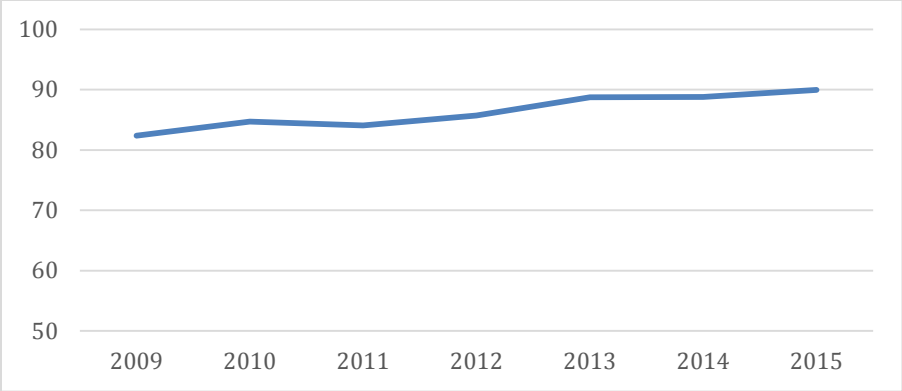


Figure 6-3: Saskatoon one-dose by age two MMR coverage rate between 2009 and 2015

	2009	2010	2011	2012	2013	2014	2015
Rates	82.38	84.70	84.08	85.72	88.74	88.77	89.96

Table 6-1: Saskatoon one-dose by age two MMR coverage rate between 2009 and 2015

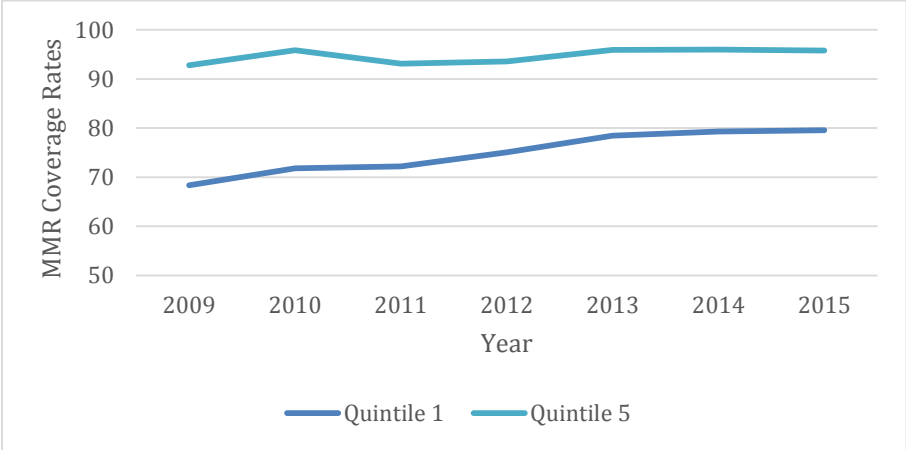


Figure 6-4: Saskatoon one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood coverage quintiles

Quintile	2009	2010	2011	2012	2013	2014	2015
Rate Ratios	1.36	1.33	1.29	1.25	1.22	1.21	1.20
Lower Limit	1.18	1.19	1.13	1.09	1.08	1.07	1.06
Upper Limit	1.54	1.48	1.45	1.40	1.37	1.35	1.34

Table 6-2: Saskatoon one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood coverage quintiles

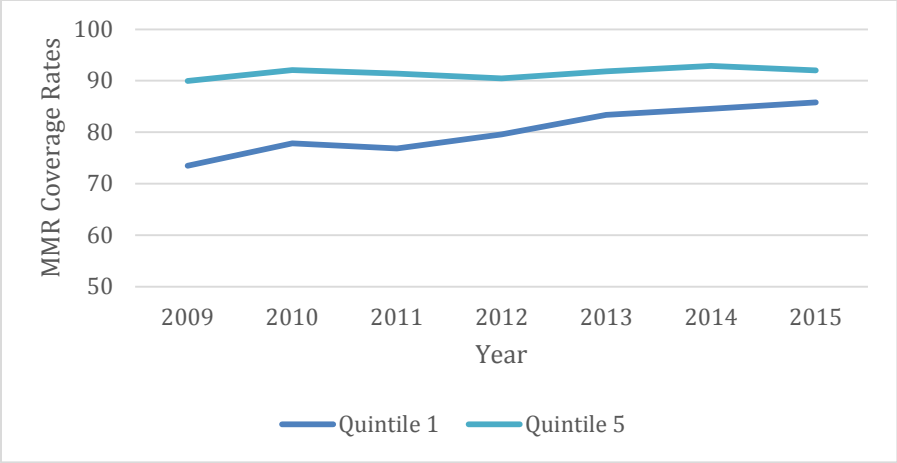


Figure 6-5: Saskatoon one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood income quintiles

Quintile	2009	2010	2011	2012	2013	2014	2015
Rate Ratios	1.22	1.18	1.19	1.14	1.10	1.10	1.07
Lower Limit	1.07	1.05	1.05	1.00	0.97	0.97	0.95
Upper Limit	1.40	1.34	1.35	1.29	1.25	1.24	1.21

Table 6-3: Saskatoon one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood income quintiles

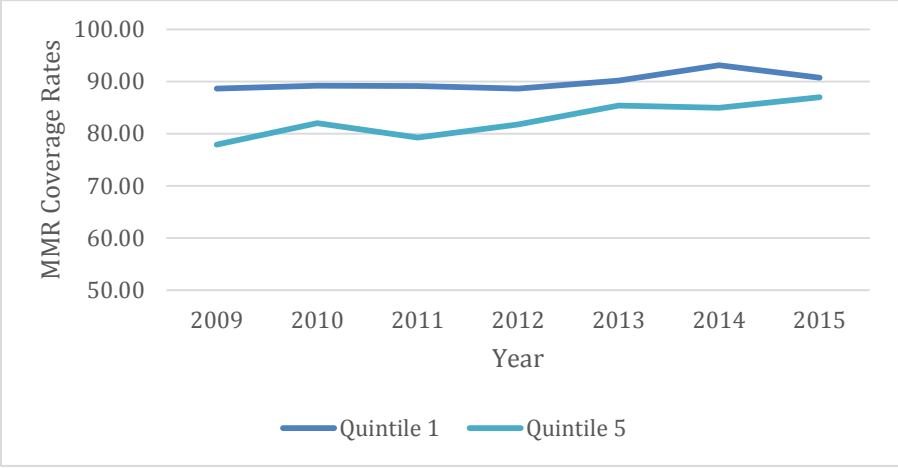


Figure 6-6: Saskatoon one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood %-aboriginal quintiles

Quintile	2009	2010	2011	2012	2013	2014	2015
Rate Ratios	1.14	1.09	1.13	1.08	1.06	1.10	1.04
Lower Limit	1.01	0.97	1.00	0.97	0.94	0.98	0.93
Upper Limit	1.29	1.22	1.27	1.22	1.19	1.23	1.17

Table 6-4: Saskatoon one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood %-aboriginal quintiles

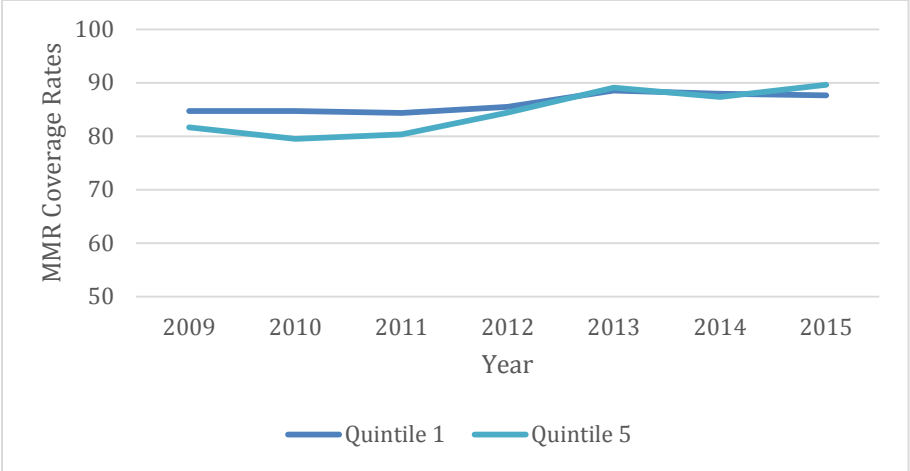


Figure 6-7: Saskatoon one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood %-immigrant quintiles

Quintile	2009	2010	2011	2012	2013	2014	2015
Rate Ratios	1.04	1.07	1.05	1.01	0.99	1.01	0.98
Lower Limit	0.92	0.94	0.93	0.90	0.88	0.89	0.87
Upper Limit	1.17	1.20	1.19	1.14	1.12	1.13	1.10

Table 6-5: Saskatoon one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood %-immigrant quintiles

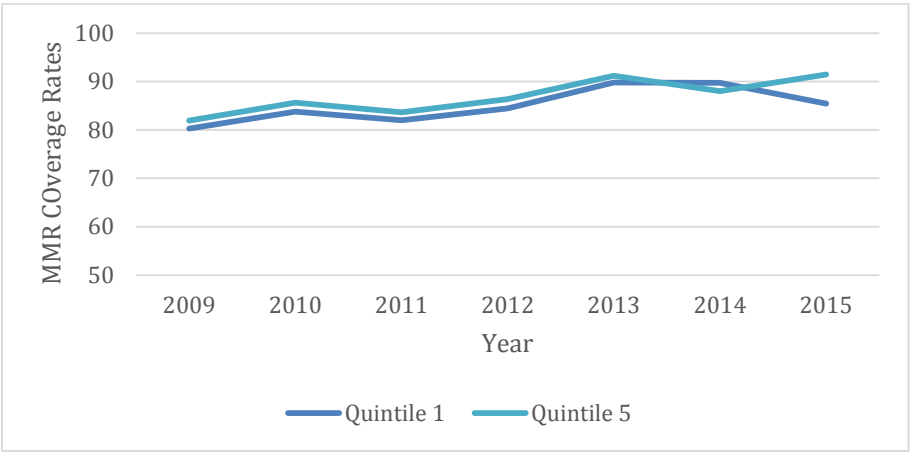


Figure 6-8: Saskatoon one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood %-home-ownership quintiles

Quintile	2009	2010	2011	2012	2013	2014	2015
Rate Ratios	1.02	1.04	1.01	1.04	1.02	1.03	1.07
Lower Limit	0.90	0.92	0.89	0.92	0.90	0.92	0.95
Upper Limit	1.16	1.18	1.14	1.17	1.15	1.16	1.21

Table 6-6: Saskatoon one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood %-home-ownership quintiles

6.3 Regina

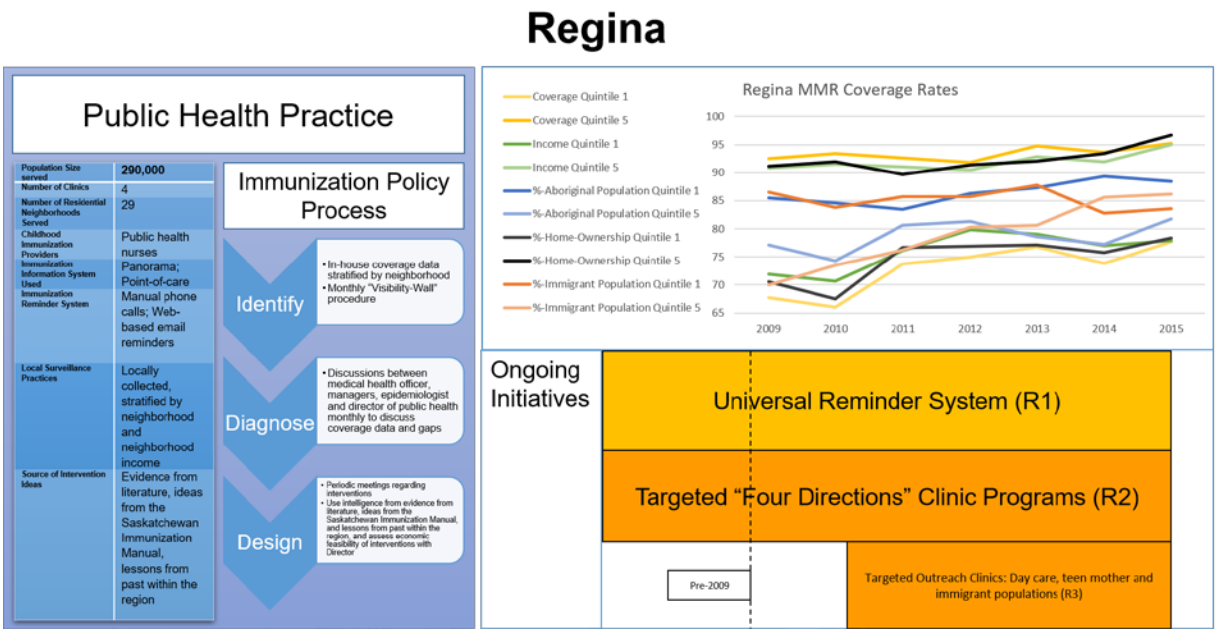


Figure 6-9: Regina results summary

6.3.1 Public Health Practice

The Population and Public Health Department of the Regina Qu'Appelle Health Region operate seven primary health care networks (4 in city, 3 rural) serving 290,000 residents (Regina Interview 1), including those living in the 29 residential neighbourhoods in Regina. Nurses deliver immunizations in four urban child health clinics and are *employed* within primary health care networks, separate entities apart from public health, while *receiving direction* from the Population and Public Health department, which is unique from the other jurisdictions. Immunizations are in the portfolio of one of the two total RQHR Medical Officer of Health whom manages the entire region.

Three of the four primary health care centres serve as dedicated public health offices to serve their respective catchment areas, where parents can bring their children in specifically for immunizations. The other clinic is designed as a multi-disciplinary community health centre located in Regina's lowest SES catchment area (core neighbourhoods) and provides immunization as one of many public health services

to the community. This clinic was from its inception in 1993, designed together with Aboriginal organizations to meet the specific needs of the local Aboriginal population (Regina Qu'Appelle Health Region, 2018a).

The health care networks under which public health nurses work are largely autonomous to conduct local programming, while the central public health office conducts larger-scale coordinated interventions and provides guidance to the networks. Centrally, coverage data is stratified by neighbourhood and posted on the walls of the public health office. These "Visibility Walls" are a recent innovation in Regina that provide a permanent space for up-to-date visual quality improvement data feedback (Regina Qu'Appelle Health Region, 2018c). In Regina, the Population and Public Health office have childhood immunization coverage data, stratified by social determinants of health, posted to track if targets are being met, and geographically where immunization coverage may be waning. This allows Regina public health to stay up-to-date on coverage rates and to identify which networks they have to alert and work with to improve coverage rates. The integration of mapping software into public health measurement is also cited as a particularly successful innovation in helping to target low-coverage areas (Regina Qu'Appelle Health Region, 2018b). This technology is centrally utilized by an epidemiologists and generates area-based data for the "Visibility Walls" of Population and Public Health, where monthly neighbourhood rates are posted in the halls of the central office.

An epidemiologist, medical health officer, director of public health and two managers conduct monthly meetings to discuss immunization trends, and send the networks lists of under-immunized individuals and coverage rates for their respective jurisdiction (Regina group interview). This structure also serves as an accountability measure for the networks to maintain and improve coverage rates across the region. This constant communication with the networks allows them to also identify populations to reach.

6.3.2 Interventions: Universal and Targeted Interventions

6.3.2.1 Universal

The recall reminder programming, which started in 2008, was the most salient recent universal immunization program innovation in Regina (Diener, 2017) and was developed as an overall deliberative goal to increase immunization coverage in the region (Bascu & Macqueen Smith, 2011). As mentioned earlier, a recall list for (at least) the first dose of MMR is sent from Regina public health to the networks monthly, alerting staff of children who have not been immunized within the ages of 3 months, 16 months, 18 months, and 20 months, where nurses and clerical staff conduct individual reminder calls (Bascu & MacQueen Smith, 2011). Figure 6-10 shows the reminder/recall process that nurses and clerks would follow as of 2011 in Regina Qu'Appelle Health Region. Since its implementation, Regina Public Health has been refining the remind/recall schedules to stay in line with the province's guidelines. The RQHR also developed a universal interactive web-based immunization reminder program called Immutrax between 2010 and 2011 **(R1)**, which, as of 2011, had registered 487 emails, representing 666 children (Bascu & MacQueen Smith, 2011). It has since been replaced by the Public Health Agency of Canada-funded CANImmunize self-administered phone application (CanImmunize, 2018).

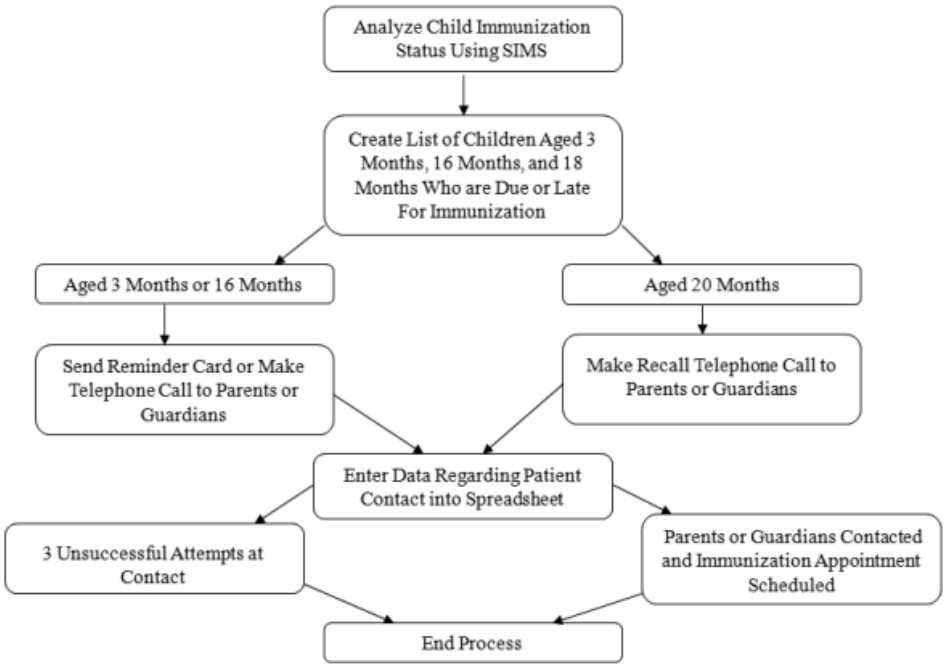


Figure 6-10: Regina Qu'Appelle Health Region reminder/recall process as of 2011. Reprinted from Bascu & MacQueen Smith, 2011

6.3.2.2 Targeted Interventions

Health equity and the social determinants of health are cited as priorities in the region overall around 2008 and 2009. While immunization was already on leadership's radar in 2008 (Bascu & MacQueen Smith, 2012), the RQHR Annual Report 2009/2010 mentions reducing "health disparities" overall as a goal of the region, citing that participating as a case study for a national study on health equity in 2008 facilitated their commitment to reducing disparities in the region (Regina Qu'Appelle Health Region, 2010). Since then, the Regina public health program intentionally targeted low coverage populations in a particularly low-income section of the city by coordinating local programming with the corresponding primary health care network.

The speciality clinic located in the lowest socioeconomic status area of Regina is by design an ongoing targeted intervention. Among the many public health programs offered by this clinic, the Teddy Bear Clinic (launched in 2006) is a yearly, continuously-improving program that public health staff cite as

particularly successful in targeting under-immunized populations (Regina Qu'Appelle Health Region, 2012). Families, mostly from the surrounding neighbourhoods, bring their children and their children's toy dolls to run through health education programs, including health checkups, sun safety and immunizations for them, their parents and their toy dolls. Though it does not directly target children under two-years old it connects families with public health staff and infants are also immunized if they come with families (**R2).**

Other centrally-organized targeted initiatives include the integration of nurses into day care for 6 months a year in low income neighbourhoods (Regina Qu'Appelle Health Region 2011), pop-up clinics, extended clinic hours, and nurse outreach into the Open Door society (targeting immigrant populations) and the Shirley Schneider Support Centre (targeting teen mothers in high school) (**R3)** (Regina Qu'Appelle Health Region, 2012). Coordinating the use of incentives (grocery store cards, children's books, etc.) was mentioned as being successful in connecting low income residents with public health.

6.33 Outcomes:

Regina experienced rising overall MMR coverage rates overall between 2009 and 2015 (82.25% to 87.65%), and persistent but reducing area-based geographic MMR coverage rate inequities (RR^{range}= 1.37 in 2009 to 1.22 in 2015; $Rates^{bottom\ quintile}$ = ~68% to ~78%; $Rates^{top\ quintile}$ = ~94% to ~97%). When adding the area-based social determinants of health indicators to the analysis, the evidence shows clear coverage gap-reducing trends based on neighborhood income (RR^{range}= 1.26 in 2009 to 1.22 in 2015; $Rates^{bottom\ quintile}$ = ~70% to ~80%; $Rates^{top\ quintile}$= ~91% to ~94%), %-immigrant population (RR^{range}= 1.24 in 2009 to 1.01 in 2015; $Rates^{top\ quintile}$ = ~70% to ~86%; $Rates^{bottom\ quintile}$ = ~83% to ~86%) and %-homeownership population ($RR^{bottom\ quintile}$= 1.17 to 1.36; $Rates^{top\ quintile}$ = ~68% to ~78%; Rates in top quintile = ~90% to ~96%). The trend with regard to the %-aboriginal population stratifier is less clear; the trend shows reductions in inequities from 2009 (RR = 1.11) to 2012 (RR = 1.06), then back up for three years at an RR range between 1.11 and 1.16. There is also an anomalous regression towards increasing inequities in all indicators except %-immigrant population in 2014. I did not find a reason as to why this result occurred in 2014. Coverage rates across all the stratifiers showed an upward trend during the study period.

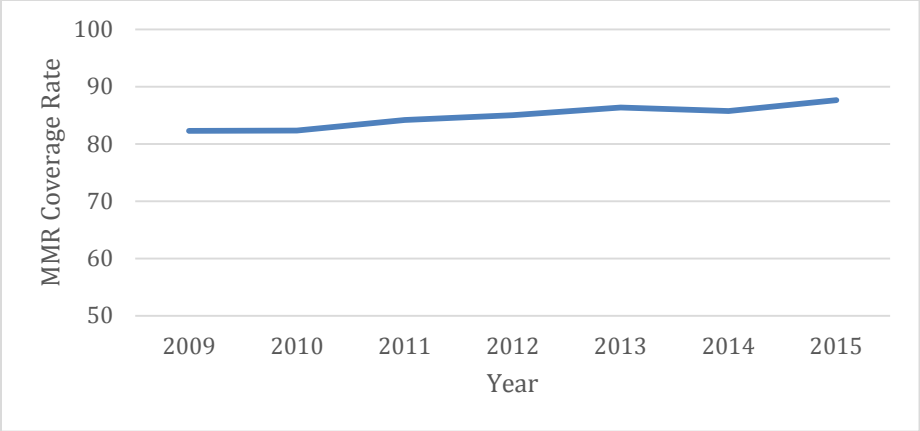


Figure 6-11: Regina one-dose by age-two coverage rates from 2009 to 2015

	2009	2010	2011	2012	2013	2014	2015
Rates	82.25	82.30	84.16	85.01	86.37	85.71	87.65

Table 6-7: Regina one-dose by age-two coverage rates from 2009 to 2015

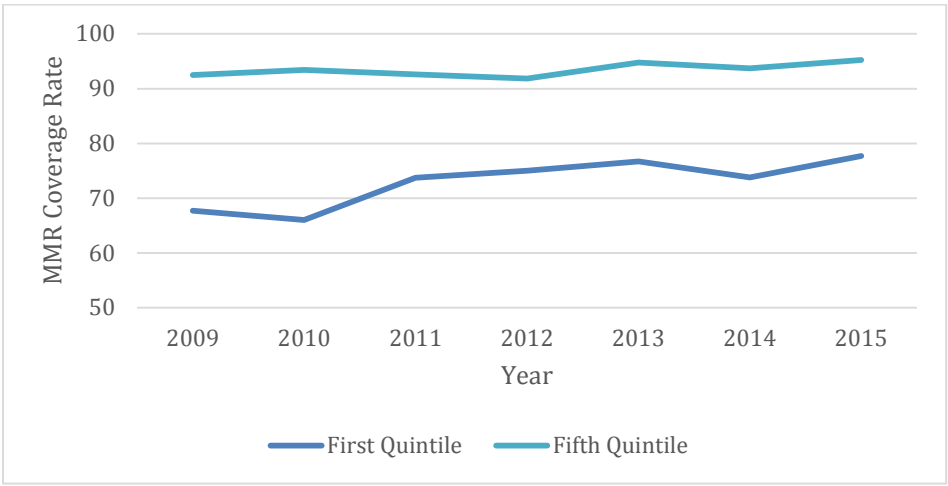


Figure 6-12: Regina one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood coverage quintiles

Quintile	2009	2010	2011	2012	2013	2014	2015
Rate Ratios	1.37	1.41	1.26	1.22	1.24	1.27	1.23
Lower Limit	1.18	1.21	1.10	1.07	1.07	1.11	1.08
Upper Limit	1.58	1.66	1.44	1.40	1.43	1.46	1.39

Table 6-8: Regina one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood coverage quintiles

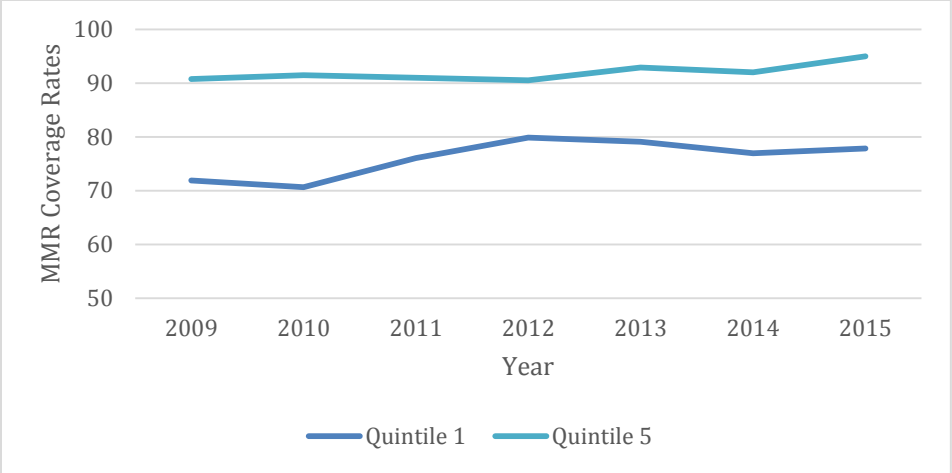


Figure 6-13: Regina one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood income quintiles

Quintile	2009	2010	2011	2012	2013	2014	2015
Rate Ratios	1.26	1.29	1.20	1.13	1.17	1.20	1.22
Lower Limit	1.09	1.12	1.04	0.99	1.03	1.05	1.07
Upper Limit	1.46	1.50	1.38	1.30	1.35	1.37	1.40

Table 6-9: Regina one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood income quintiles

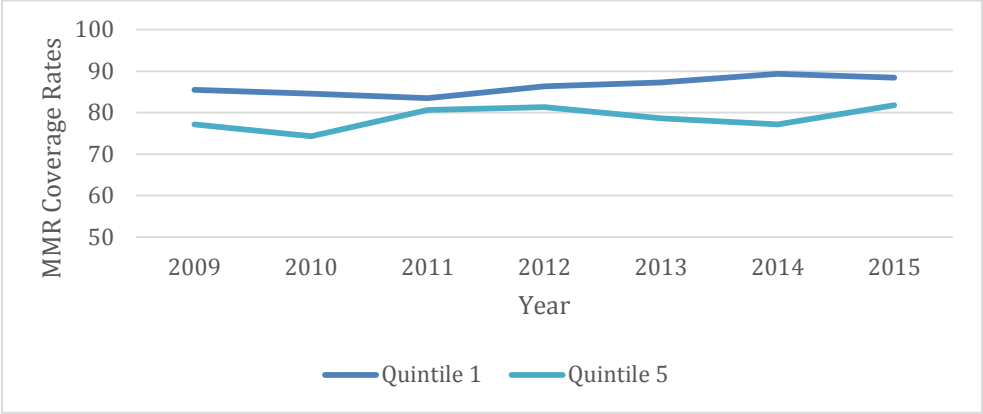


Figure 6-14: Regina one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood %-aboriginal population quintiles

Quintile	2009	2010	2011	2012	2013	2014	2015
Rate Ratios	1.11	1.14	1.03	1.06	1.11	1.16	1.14
Lower Limit	0.97	0.98	0.90	0.93	0.97	1.01	0.91
Upper Limit	1.25	1.30	1.17	1.19	1.25	1.30	1.37

Table 6-10: Regina one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood %-aboriginal population quintiles

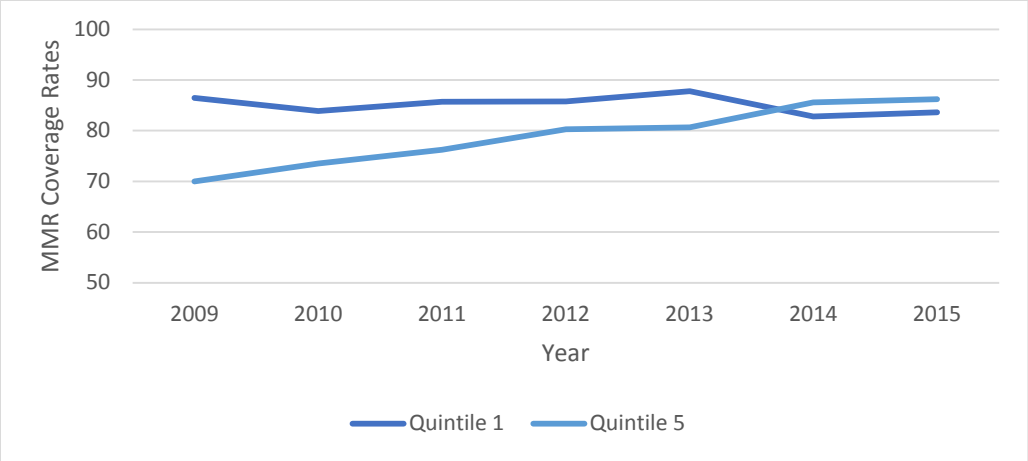


Figure 6-15: Regina one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood %-immigrant population quintiles

Quintile	2009	2010	2011	2012	2013	2014	2015
Rate Ratios	1.24	1.14	1.12	1.07	1.09	0.97	0.97
Lower Limit	1.06	0.99	0.98	0.93	0.95	0.85	0.84
Upper Limit	1.44	1.32	1.29	1.23	1.25	1.10	1.12

Table 6-11: Regina one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood %-immigrant population quintiles

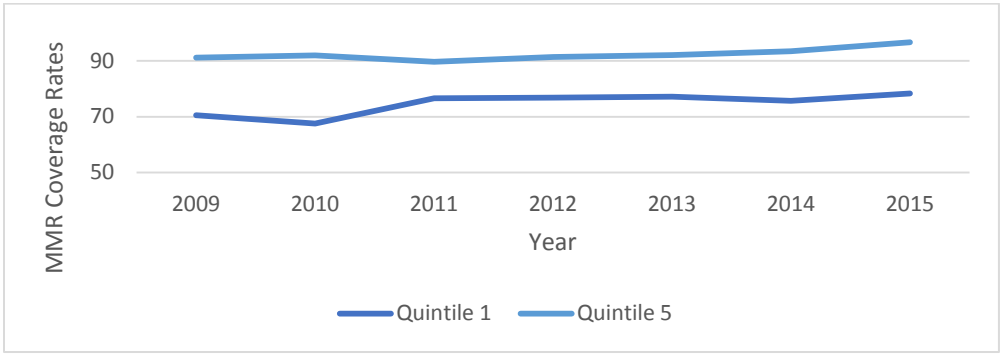


Figure 6-16: Regina one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood %-home-ownership quintiles

Quintile	2009	2010	2011	2012	2013	2014	2015
Rate Ratios	1.29	1.36	1.17	1.19	1.19	1.23	1.23
Lower Limit	1.13	1.18	1.03	1.04	1.04	1.09	1.03
Upper Limit	1.48	1.57	1.33	1.36	1.36	1.40	1.47

Table 6-12: Regina one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood %-home-ownership quintiles

6.4 Alberta

6.4.1 Context over time

Public health policy in Alberta is created by the provincial Ministry of Health, Alberta Health, in collaboration with the provincial health authority, Alberta Health Services. The policies are then operationalized by five regional administrative "zones" of Alberta Health Services: North, Edmonton, Central, Calgary and South, under which public health staff deliver services. All childhood immunizations are primarily delivered by public health nurses at AHS community health clinics in both Calgary and Edmonton.

It is important to consider that Alberta experienced a massive health care restructuring in 2008, one year before the beginning of this study's period. Where there were previously nine independent health authorities, and three specialized provincial entities responsible for mental health, addictions, and cancer, respectively, there is now a single authority, with one board and CEO (Philippon, 2018). It is overall unclear whether provinces experience better health outcomes after centralization (Van Aerde, 2016). It is even less apparent what Alberta's transition did to public health services and delivery as there has been no systematic investigation into this issue. Nevertheless, one must appreciate the fact that for the period in which this study is investigating (2009 to 2015), Calgary and Edmonton public health zones are operating in an imminently post-reform context.

The period between 2007 and 2009 also saw a major development in high-level policy and action regarding immunizations in general. In 2007, Alberta provincial government released their *2007-2017 Alberta Immunization Strategy* "to address the immunization barriers and to explore evidence-based strategies to overcome these barriers" (Alberta Health, 2007, p.11).

"The goal of the Alberta Immunization Strategy (AIS) is:
'to minimize the risk of vaccine-preventable diseases as evidenced by an increase in immunization rates.'

This goal is to be achieved through seven evidence-based strategic directions:
1. Enhance Accessibility
2. Improve Enabling Technology

3. Strengthen Parental Education and Counseling
4. Strengthen Partnerships
5. Strengthen Provider Training and Education
6. Strengthen Public Education and Awareness
7. Strengthen Research and Evaluation" (Alberta Health, 2007, p.4)

The strategy culminated in the launch of the Immunization Innovation Fund, an $8 million investment into projects aimed to raise immunization rates in hard-to-reach populations, over two years (Alberta Health Services, 2015a; McInnes & Kennedy, n.d.) **(C3, E4).** AH published an evaluation of 5 of the "Urban Outreach IIF Project" programs which took place in Calgary, two of them including demographics matching the 0 to 2-year-old study population: 'Low Income Housing IIF Project' targeting nine sites that serve low income clients, and the 'Margaret Chisholm Resettlement Centre (MCRC) (refugees) Project' program **(C3).**

The Low income Housing IIF Project involved outreach of multidisciplinary staff physically delivering services at known low-income locations, addressing residents and clients one-on-one. Overall, across all the sites, around 25% of clientele were 0-3 years-old over the two-year period (2007-2009). The evaluation found a 21% increase in "adequate coverage" rates between 2007 and 2008 and a 25% increase between 2008 and 2009. The MCRC refugee program involved increasing public health nursing hours at the in-house refugee clinic from 8 hours to 16 hours a week. Overall, in 2007-2008, 9% of clientele were 0-3 years old and in 2008-2009, 42% of the clientele were 0-3 years old. The evaluation found a 23% increase in "adequate coverage" rates between 2007 and 2009 and a 39% increase between 2008 and 2009 (McInnes & Kennedy, n.d.).

In Edmonton, it was reported by an interviewee that this money was used to investigate coverage rates in combination with the social determinants of health and to target immunization in daycares in selected catchment areas, the Edmonton Young Offenders Centre, and to areas with pockets of refugees, throughout the city. The data on these targeted interventions are no longer being collected and the fund is

not in existence, though local public health units have tried not to withdraw any services that were successful (Edmonton group interview) **(E4).**

While the evaluations cite specific recommendations for the future of these projects, there is no publicly available literature on these interventions post-2009. Indeed, one interviewee suggest that "those initiatives were probably the last of the initiatives that were targeted at low-income and equity. There have been very little geared toward that basically because of the increasing demand to just maintain our routine program because of the population growth" (Edmonton manager, Edmonton interview #2). Data compiled from AHS Annual Reports (Figure 6-17 / Table 6-13) show an increase of 1.7% in provincial one-dose MMR coverage rates between 2008 (85.0%) and 2009 (86.7%).

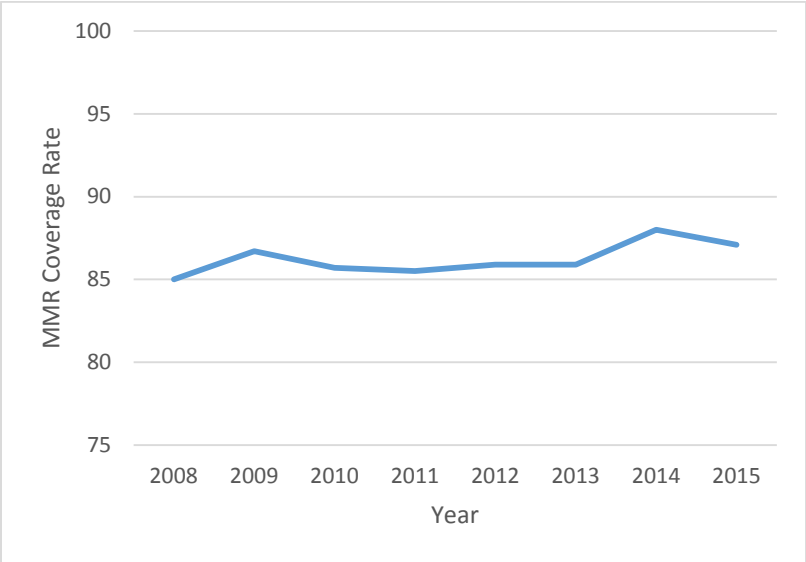


Figure 6-17: Alberta one-dose by age-two MMR coverage rates for 2009 to 2015

	2008	2009	2010	2011	2012	2013	2014	2015
Coverage Rates	85.01	86.70	85.70	85.50	85.90	85.90	88.00	87.10

Table 6-13: Alberta one-dose MMR by age-two coverage rates (Alberta Health Services, 2013, 2015c)

Improving immunization rates appears in the 2010-2011 AHS annual report as a priority for action under the "Building a Primary Care Foundation" target. The MMR annual target is set to 95%. A provincial immunization steering committee was created at this time, with two initiatives underway: A literature review of strategies to improve rates and an environmental scan of currently implemented strategies within each zone (Alberta Health Services, 2011). Plans for improved timely, zone-based coverage rate reporting are also mentioned. The combined MMR vaccination is launched provincially in September 2010 (Alberta Health Services, 2011). 2010 also saw the provincial roll-out of Health Link child health electronic reminder system **(C1, E1)**, a subscription service that sends out reminders regarding childhood milestones, including immunizations, based on the child's age.

In 2011-2012, AHS in collaboration with the Ministry lists the following as an action towards "Improving Immunization Rates" as a "Priority for Action: Prevention":

> "In conjunction with zone operations, develop plans to address childhood immunization rates. This will include review of evidence-based strategies to address immunization and consultations to identify: 1) barriers to immunization; 2) barriers to access immunization clinics; 3) need for parent education/consultation; and 4) immunization data collection across the province" (Alberta Health Services, 2012, p.46).

Progress towards this action includes the implementation of reminder phone calls and mail outs, extra drop-in clinics in high no-show communities, and partnerships with day cares to identify under-immunized children.

The 2012-2013 AHS report makes mention of public health being a part of the Access Improvement Measure (AIM) initiative to reduce immunization wait times in clinics. The aforementioned survey analysis is reported as "ongoing" and the Alberta Immunization Strategy 5-Point Refresh work is mentioned as "underway" (Alberta Health Services, 2013).

The major MMR-related highlight of the 2013-2014 season is the provincial measles outbreak, where mass immunization clinics, dedicated hotline, a mobile measles assessment team, quarantine and exclusion measures, and open public health communication initiatives were deployed across the province (Alberta Health Services, 2014a; Kershaw, Suttorp, Simmonds, & T, 2015). Concurrently, it is reported that the aforementioned AIM initiative helped reduce immunization wait times from 28 days to as low as 14 days. In this period, MMR immunization rates are added as a "Performance Measure" of the Ministry, where a target of 98% is emphasized. An "early dose" of vaccine was also approved for children six months to less than 12 months of age, Alberta-wide for infants from or travelling to Calgary, Central or Edmonton Zones, an initiative that lasted almost 2 months during the height of the outbreak (Alberta Health Services, 2014c, 2014b). The result of the outbreak and subsequent immunization campaign raised the rates of one-dose by age 2 immunizations almost 3 percentage points in one year, up to 88.0 % **(C4, E5)** (Gerein, 2015).

Around this period, Albertan scientists were dedicated to researching childhood immunization across the province. AH professionals at The Western Canada Immunization Forum 2014 presented some operational updates to the Strategy with an emphasis on "Enhancing Data & Information Management", where they highlighted a study they conducted showing an income gradient in MMR coverage at age 7, across the province (Your Alberta, 2014). Risk factors shown to reduce childhood immunization coverage rates in Alberta include # of children in the family at birth (family size), maternal age, midwife and other (non-physician or nurse) birth attendant, unmarried marital status and rural birth. The rural/urban divide of coverage rates in Alberta has also been corroborated elsewhere (Johnson, Kneebone, 2015). They also presented their innovations in utilizing geographical analysis to understand coverage gaps by outlining an area-based study, measuring Diphtheria-Tetanus-Pertussis immunization first-dose and fourth-dose coverage. Low first-dose coverage rates were found to be correlated with having ≥ 3 children in a family, and exposure to a previous outbreak. Low fourth-dose coverage rates were found to be correlated with having poor access to a regular family physician, moving houses, having ≥ 3 children in a family,

exposure to a previous outbreak, and the occurrence of influenza-like illnesses among the parents. By adjusting for known risk factors of low coverage rates, map-based epidemiology is presented as a particularly effective tool for informing public health programming.

September-December 2014 then saw the provincial implementation of www.immunizealberta.ca, an immunization information hub **(C2, E2)** for that reached 118,900 people as of 2015. This website provides evidence-based answers to frequently asked questions regarding childhood immunization (Alberta Health Services, 2015a).

The 2014-2015 AHS Annual Report discusses the success of reaching low-German speaking Mennonite populations through education sessions in the South Zones during the 2013/2014 outbreaks. In this period, the Ministry reports that the sharp increase in MMR rates was due to "the work done by AHS to rationalize workload in each of the zones, reducing clinic wait times and working on better collection and reporting of immunization data at the local geographical level" (Alberta Health Services, 2015b, p.21) as well as due to the extra clinics offered in the wake of the outbreak.

In 2015, both the AHS and AH report a drop in MMR coverage rates by 0.9% (88.0% to 87.1%). AH mentions that the possible reasons for that drop include parental beliefs in safety/efficacy and the rise of misinformation. The ministry reports that they will be focusing on educating health professionals and parents about safety and efficacy to foster informed parental decisions. Improvements in wait times and better local geographic coverage rate collection methodologies are mentioned as valuable work towards informing future strategies to improve coverage rates (Alberta Health Services, 2015a).

Regarding area-based reporting in general, Alberta Health publicly releases "How Healthy Are We?" (Alberta Health Services, 2018c) health profiles, updated up to 2010, that lists socioeconomic indicators and health summary indicators by AHS custom-made zonal geographies. These reports do not, however, include immunization coverage as one of the health summary indicators.

6.5 Calgary

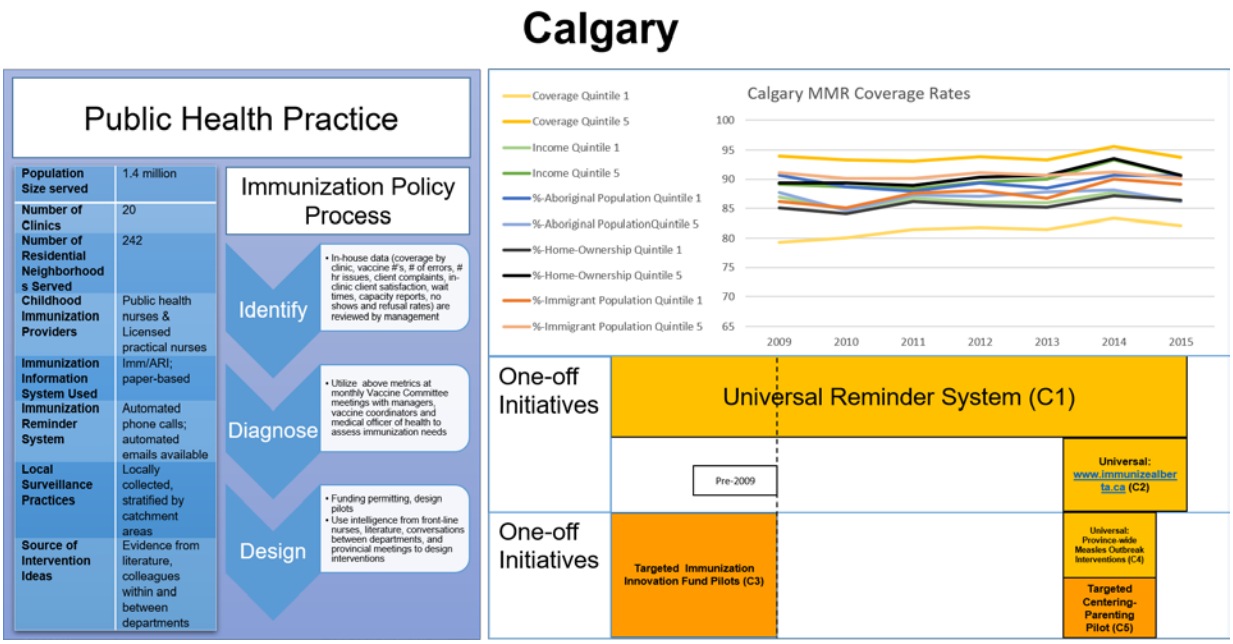


Figure 6-18: Calgary results summary

6.5.1 Public Health Practice

Calgary zone public health provides MMR immunizations to approximately 1.4 million residents (Alberta Health Services, 2018a). Within the metropolis of Calgary, there are 20 public health clinics providing childhood immunization to 242 neighbourhoods (Alberta Health Services, 2018e). For context, it is important to note that over the 8 year time span, as the population and the number of vaccinations grew, public health resources stagnated in Calgary. For example, in Calgary this strain on capacity led to management increasing the scope of practice of licensed practical nurses (LPNs) to begin to deliver childhood immunizations. According to one public health official, this policy shift represents 'doing more with less':

> "The priority is still to deliver immunizations in a cost-effective manner, but FTE hasn't changed over the last ten years. It has been basically stagnant, but the number of immunizations has increased. So we have seen a shift on who delivers our products. We have more LPN's deliver our products and also other work is being done to a lesser extent: So less health promotion, less screening, that kind of thing.

…It's hard to increase coverage rates when you don't have increased resources"

– Calgary Manager (Calgary interview #2)

While this may be the case for other cities, this was a particularly salient message throughout the Calgary-based qualitative data.

As mentioned earlier, MMR immunizations are delivered primarily in public health clinics, called Community Health Centres, by public health nurses (RN) and licensed practical nurses (LPN). The provincial registry system Imm/ARI (Immunization and Adverse Reaction to Immunization) first captures clients at birth. Utilizing this database, an automated phone call reminder is generated by an auto-dialer system at 9-10 months, again at 16 months, 21 months and kindergarten to remind parents to bring children to the clinics for their vaccinations (Calgary interview #1). At 21 months if they are still missed, the home is called by a clerk to try to arrange an appointment. When the parent and child are in the clinic, an RN or an LPN spend up to 40 minutes in consultation (Calgary interview #1), where an array of maternal and child health assessments are completed, immunizations are delivered, with elements of health teaching throughout.

In lieu of continuing the large, IIF city-wide interventions during this time period (except during the outbreak), Calgary public health programming conducts iterative programmatic interventions at each clinic based on the observations of the front-line workers (Calgary interview #2). Nurses are trained to assess high-risk patients (abuse, risks of failure to thrive, development to thrive), patient satisfaction, and patient safety risks and errors.

Combined with frontline wisdom, metrics like number of vaccines, number of errors, number of HR issues, client complaints, client satisfaction (captured by a survey at the clinic), wait-times, capacity reports, no shows and refusal rates are all captured and taken into consideration when planning an intervention. These metrics are considered enough input to inform quality improvement initiatives, with the caveat that metrics like the client survey, for example, "would not capture the people who *don't*

vaccinate" (Calgary interview #2). These metrics feed into a bottom-up hierarchy of reporting, from front line professionals, to supervisors, managers, a vaccine coordinator across clinics, and to the Medical Health Officer with the immunization portfolio, who also receives reports from an in-house public health analyst. The data is gathered and culminates into a discussion at a monthly Vaccine Committee meeting, where programmatic and policy decisions are discussed among the members.

Intervention ideas come from front line professionals, literature, consultation with the Communicable Disease department, provincial meetings and/or from colleagues. The interventions are then discussed in terms of resources-needed, with the final decision made by the Director, in consultation with the Managers.

6.5.2 Interventions: Universal and targeted interventions

6.5.2.1 Universal

A phone-based reminder system described earlier was in place throughout the study period, though the automation of this system is a more recent phenomenon, implemented around 2014 (CBC News, 2018). In 2010, the phone-based reminder system was supplemented by the Health Link email-based subscription reminder system. It was also mentioned that to a limited extent, texting-pilots have been implemented to reach those whom may have phones that do not receive calls **(C1)** (Calgary interview #2).

The most extensively-reported universal childhood-immunization intervention within the study period was in 2014 during a measles outbreak response in Alberta (Alberta Health Services, 2014a). This involved a provincial effort to deploy mass immunization clinics, mobile measles assessment teams, and a dedicated hotline, much of which was dedicated to the "South Zone", where most of the outbreak occurred among known vaccine-refusing communities of Dutch origin (Kershaw et al., 2015). Once the outbreak was declared April 2014 after 22 confirmed cases in Alberta, nine of which were in Calgary (6 in Edmonton, 7 in Central Alberta) (Geddes, 2014). Calgary zone deployed the mass immunization clinics (Calgary interview #2) in sites usually used during mass flu immunization season. Later that year, it was

reported that this massive increase in demand was stressing the routine public health system, where waits for immunization were delayed up to three months, forcing nurses' unions to call for AHS to "bump-up staffing levels and expand clinic hours to help clear the backlog" (CBC News, 2018) **(C4).** At this time, as with the rest of the province, parents in Calgary also had access to the aforementioned www.immunizealberta.ca , a universal education campaign (**C2).** Figure 6-19 illustrates a noticeable influx of services in the 2014 data, showing a 2% increase overall across the city (88.7% – 90.7%).

6.5.2.2 Targeted Programs

Calgary public health interventions are targeted on clinics from which front-line concerns arise. The relative priority of feedback metrics explained earlier, and their alignment with ideas for solutions the vaccine committee may have, dictate which clinics receive interventions (Calgary interview #1).

The impact made by the targeted equity-related interventions mentioned earlier in the Urban Outreach IIF initiative between 2007 and 2009 is difficult to assess due to the lack of pre-2009 data (**C3).** Overall, conducting equity-based targeted interventions was not an explicit goal within the childhood immunization Calgary urban public health program during the study period (2009-2015). However, "High-risk population" screening does occur, but more on an individual basis by nurses during the appointments. As mentioned before, these reporting metrics do filter upwards through management, though no specific targeted equity-based intervention based on this reporting pathway was reported to occur during the study period.

The one reported targeted intervention was a small pilot intervention and limited in its reach. In 2013/2014, concerns around the increasing number of vaccinations that took time away from health promotion and early parent education activities within the 40-minute appointment structure, prompted Calgary Public Health to embark on a new model of early-childhood public health practice. This complex intervention was piloted in 2014 utilizing the "Centring Parenting" (CP) model of early-childhood health services. Designed in the United States, the Centering Parenting model builds on the Centering Pregnancy pre-natal group-based health care and social teaching delivery services care for mothers and extends it

into first-year postpartum care (Johnston et al., 2017). This model involves a short parent and infant health assessment, a shared group discussion on questions regarding the assessment, and maternal and/or paternal-topic information sessions on their own and infants' physical, mental, emotional health.

These clinics were run over six, two-hour group sessions within the first year of the child's life with 24 families. Immunizations were delivered to the children in a group setting at 2, 4, 6, and 12 months. In a 2017 evaluation of the project, the CP model was compared to previous data cohort data representing general one-on-one public health practice. Regarding immunization outcomes of this intervention, at 4-months all CP babies were up-to-date, compared to 95% of babies from the comparison group, and at 12 months, all CP babies were up-to-date while just over 50% of babies were up-to-date in the comparison group (Johnston et al., 2017). The CP clients were also more likely to have a high-school education or less and to report less than $100,000 of income than the comparison group. This intervention, while showing promising results, was not continued however, due to it being "much more expensive to run than regular immunization clinics" (Calgary interview #2) (**C5).** Overall, however, it was mentioned that "generally our strategies haven't been that targeted" (Calgary interview #2).

Another recent intervention of note is technically "targeted" but is not necessarily equity-based and was not included into the results timeline. It involved a specialized clinic dedicated to "non-routine immunizers"; "a lot of people who want to pick one vaccine today and one vaccine tomorrow" (Calgary interview #2). This clinic serves the following categories of non-routine immunization clients: "Immune-compromised individuals; transplant patients; clients requiring post-exposure prophylaxis; non-AHS health care workers; health care students; parents requesting alternate vaccine schedules for their children; clients from Elbow River Healing Lodge" (Alberta Health Services, 2018d). Calgary public health is in the process of evaluating whether these clients go back to routine care and if they have achieved all of their immunizations.

6.5.3 Outcomes

Calgary experienced stable MMR coverage rates between 2009 and 2015 (88.51% to 89.15%), except the spike between 2013 and 2014 (88.68% to 90.77%). Calgary exhibited consistent area-based geographic MMR coverage rate inequities throughout the study period (RR^{range}= 1.14 to 1.18; $Rates^{bottom\ quintile}$ = ~ 80% to ~ 83%; $Rates^{top\ quintile}$ = ~94% to ~96%). When adding the area-based social determinants of health indicators to the analysis, the data shows no statistically significant coverage gaps based on income, %-immigrant population, %-aboriginal population and %-home ownership, with an exception for %-homeownership being statistically significant in 2014 (RR = 1.07).

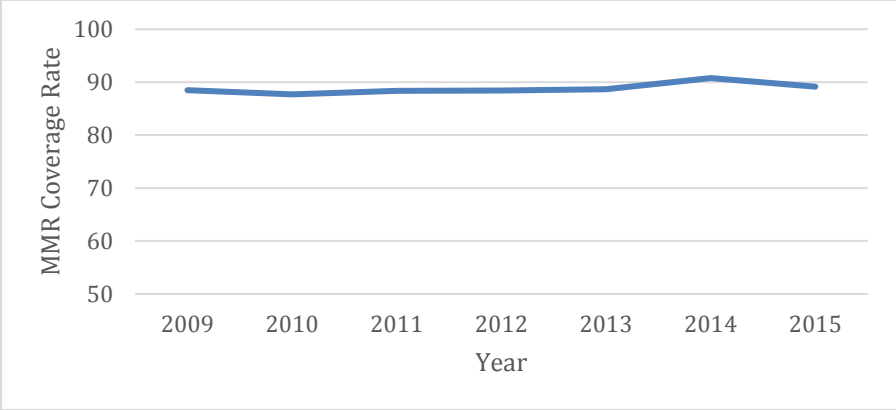


Figure 6-19: Calgary one-dose by age-two MMR coverage rates between 2009 and 2015

	2009	2010	2011	2012	2013	2014	2015
Rates	88.51	87.70	88.37	88.43	88.68	90.77	89.15

Table 6-14: Calgary one-dose by age-two MMR coverage rates between 2009 and 2015

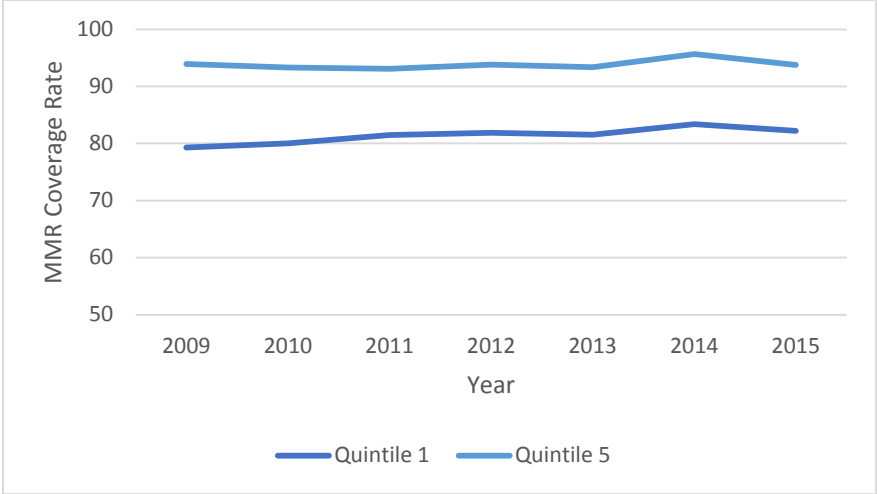


Figure 6-20: Calgary one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood coverage quintiles

	2009	2010	2011	2012	2013	2014	2015
Rate Ratio	1.18	1.17	1.14	1.15	1.15	1.15	1.14
Lower Limit	1.11	1.10	1.08	1.08	1.08	1.08	1.08
Upper Limit	1.26	1.23	1.21	1.21	1.21	1.21	1.21

Table 6-15: Calgary one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood coverage quintiles

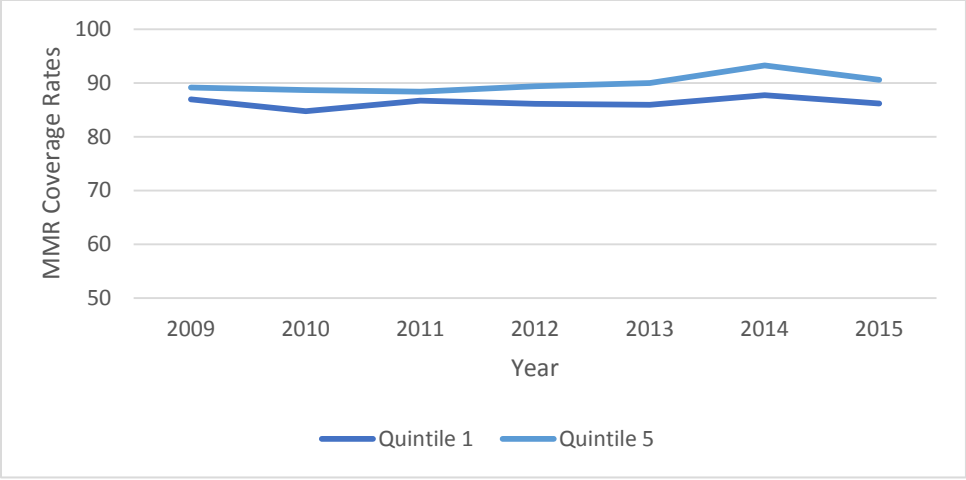


Figure 6-21: Calgary one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood income quintiles

	2009	2010	2011	2012	2013	2014	2015
Rate Ratio	1.03	1.05	1.00	1.04	1.05	1.06	1.05
Lower Limit	0.97	0.99	0.95	0.98	0.99	1.00	0.99
Upper Limit	1.09	1.11	1.05	1.10	1.11	1.12	1.11

Table 6-16: Calgary one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood income quintiles

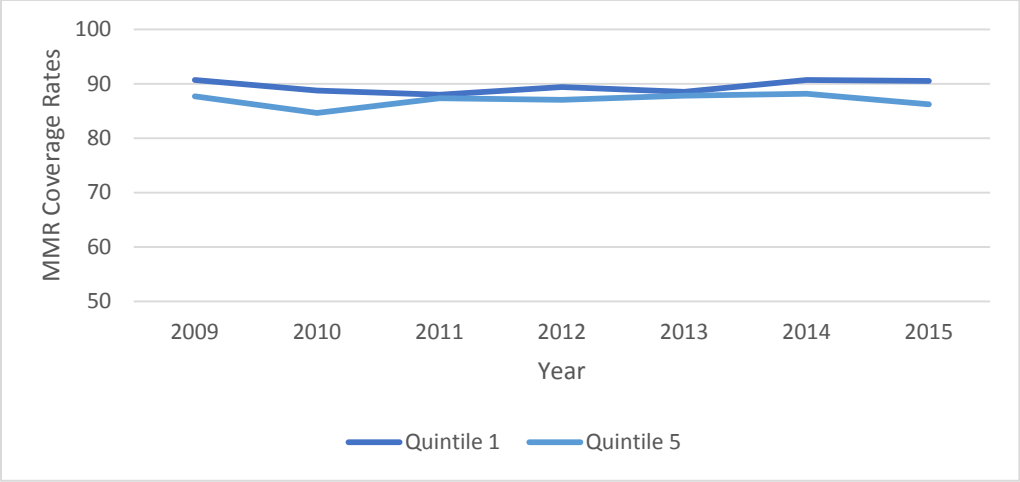


Figure 6-22: Calgary one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood %-aboriginal population quintiles

	2009	2010	2011	2012	2013	2014	2015
Rate Ratio	1.03	1.05	1.01	1.03	1.01	1.03	1.05
Lower Limit	0.98	0.99	0.95	0.97	0.95	0.97	1.00
Upper Limit	1.09	1.11	1.06	1.09	1.07	1.09	1.11

Table 6-17: Calgary one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood %-aboriginal population quintiles

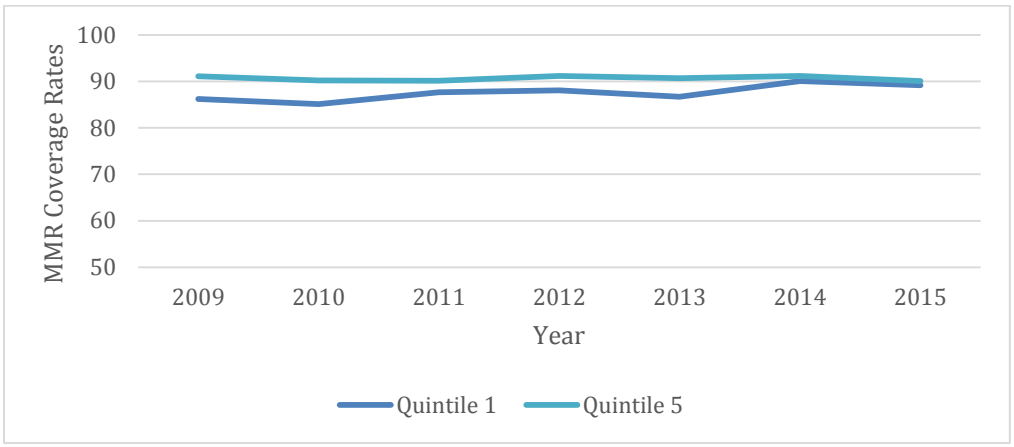


Figure 6-23: Calgary one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood %-immigrant population quintiles

	2009	2010	2011	2012	2013	2014	2015
Rate Ratio	1.06	1.06	1.03	1.04	1.05	1.01	1.01
Lower Limit	1.00	1.00	0.97	0.98	0.99	0.96	0.96
Upper Limit	1.12	1.12	1.09	1.09	1.11	1.07	1.07

Table 6-18: Calgary one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood %-immigrant population quintiles

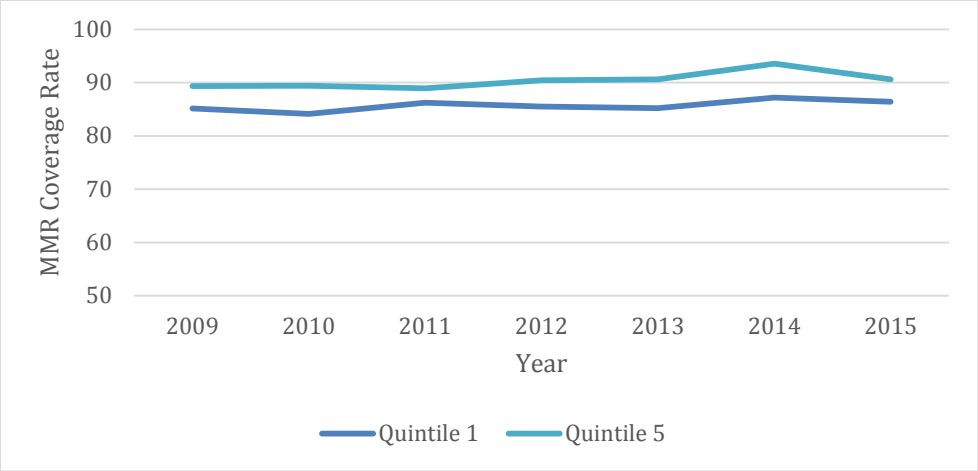


Figure 6-24: Calgary one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood %-home-ownership quintiles

	2009	2010	2011	2012	2013	2014	2015
Rate Ratio	1.05	1.06	1.03	1.06	1.06	1.07	1.05
Lower Limit	0.98	1.00	0.97	1.00	1.01	1.02	0.99
Upper Limit	1.10	1.13	1.09	1.12	1.13	1.13	1.11

Table 6-19: Calgary one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood %-home-ownership quintiles

6.6 Edmonton

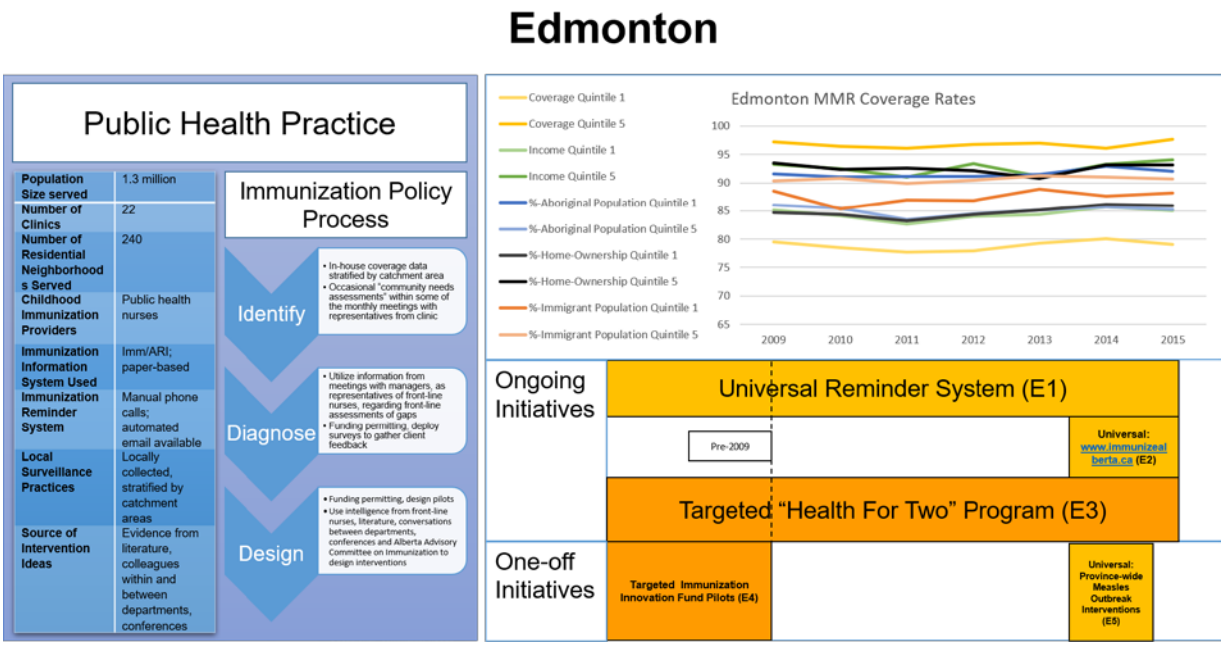


Figure 6-25: Edmonton results summary

6.6.1 Public Health Practice

Edmonton zone public health provides MMR immunizations to 1.3 million residents. Within the metropolis of Edmonton, there are 22 serving 240 residential neighbourhoods (Alberta Health Services, 2018b). Like Calgary, childhood immunizations are exclusively delivered by public health nurses, where immunization data is input through a paper-based system, though a point-of-care electronic system migration is presently underway. Paper-data is entered into the system by data clerks and sent electronically to the Alberta Health Ministry ImmARI system.

Early-childhood appointments occur 2 months, 4 months, 6 months, 12 months, 18 months with public health nurses, each being 20-50 minutes in length. It is here that immunization is provided along with a cadre of health promotion education, and post-partum depression, growth & development assessments. Unlike Calgary, reminder phone calls for these appointments are not automated; they are conducted manually by clerical and nursing staff (Edmonton interview #2) **(E1).**

Edmonton public health periodically and iteratively conduct community needs assessments for their 22 public health clinic catchment areas (Edmonton Group Interview). The community needs assessment generally involves conversations between frontline staff and managers and occur occasionally during monthly immunization meetings. These discussions involve programmatic and/or research innovations public health could be involved with to increase coverage rates in communities. Also, if funding is available, the multi-departmental group assesses how to pilot initiatives to increase the coverage rates of any given low-coverage area, utilizing evidence from literature and peers, some of whom are sent to conferences to learn innovations from across Canada. For zone-level policy and programming ideas, AHS collaborates heavily with the Alberta Health Ministry in the form of an Alberta Advisory Committee on Immunization.

Coverage data monitoring is done both locally with in-house epidemiologists as well as in collaboration with the AHS Public Health Surveillance and Infrastructure department to assess data by catchment area. They are currently working on having more regularly, automated, higher resolution coverage data delivered through the Public Health Surveillance and Infrastructure department, but for now, sub-geographical coverage data insights must be requested on-demand.

6.6.2 Interventions: Universal and targeted

6.6.2.1 Universal

As mentioned before, Edmonton's universal recall/reminder system involves unscheduled, manual calls by clerical and nursing staff, though they are currently advocating for funding to run an automated system. There were no recorded innovations in their recall/reminder system over the study period (**E1).** The launch of www.immunizealberta.ca is another universal intervention that involved the Edmonton population (**E2).**

The only other reported universal MMR interventions implemented during the study period occurred during the measles outbreak in 2014, when Alberta Health Services both increased their vaccination

messaging through the media and offered early-doses of the MMR vaccine between May and July of 2014 (Geddes, 2014) **(E2).** Overall, the public health response to the outbreak was less intense in Edmonton than in Calgary. For example, it was reported that, unlike Calgary, there were no special drop-in clinics opened in Edmonton during the 2014 measles outbreak (CBC News, 2014).

6.6.2.2 Targeted

Targeted MMR interventions largely occur on an ad-hoc basis, driven by guidance from front-line public health professionals. A particular target population reported by an interviewee in Edmonton are "delayed immunizer" parents, largely represented in two groups: those whom are hesitant and may immunize later with some extra public health educations and guidance, or those in low socioeconomic standing whom are willing to immunize but can't make an appointment work with their schedules. Edmonton is in the process of implementing satisfaction surveys to assess service-related gaps that patients may encounter in order to reduce delayed immunization, informing a future intervention for this population. For low income clients specifically, occasional drop-in clinics are implemented in affected catchment areas, and taxi and bus tickets are available to ease transportation-related barriers.

The 'Health for Two' program is a long-standing targeted intervention that provides ongoing targeted support for at-risk mothers (e.g. HIV-positive, homeless, teen, low-income, suffering from food insecurity, immigrant, and victims of domestic abuse) in Edmonton on an individual basis. Operating as a stand-alone program within public health, Health for Two deploys 4-5 nurses across Edmonton who make home visits with mother throughout pregnancy, and up to two months postpartum. The goal of this program is to provide health education and additional nutritional and transportation resources, as well as to build relationships between mothers and social and health systems, including public health (**E3).** The following quotation describes the overall childhood immunization programming in the Edmonton area:

> "So we definitely start with a population-based approach to ensure that we have enough resources to serve the entire population in each catchment area, and then with the *additional resources* (emphasis added) we really look at the social determinants of health to determine where some of

the vulnerable populations are which may need a little bit more support and a little bit more resources" (Edmonton manager, Group interview).

6.6.3 Outcomes

Edmonton experienced stable MMR coverage rates between 2009 and 2015 (88.59% to 88.59%) and consistent area-based geographic MMR coverage rate inequities throughout the study period (RR^{range}= 1.20 to 1.24, $Rates^{bottom\ quintile}$ = ~78% to ~80%; $Rates^{top\ quintile}$ = ~94% to ~95%). When adding the area-based social determinants of health indicators to the analysis, the data shows inequities based on income (RR^{range}= 1.08 - 1.11; $Rates^{bottom\ quintile}$ = as low as ~84 to as high as ~86; $Rates^{top\ quintile}$ = as low as ~91% to as high as ~94%) and %-homeownership (RR^{range}= 1.07 - 1.11; $Rates^{bottom\ quintile}$ = as low as ~84 to as high as ~86; $Rates^{top\ quintile}$ = as low as ~90% to as high as ~94%) were consistent. No statistically significant coverage gaps were detected based on %-immigrant population or %-aboriginal population.

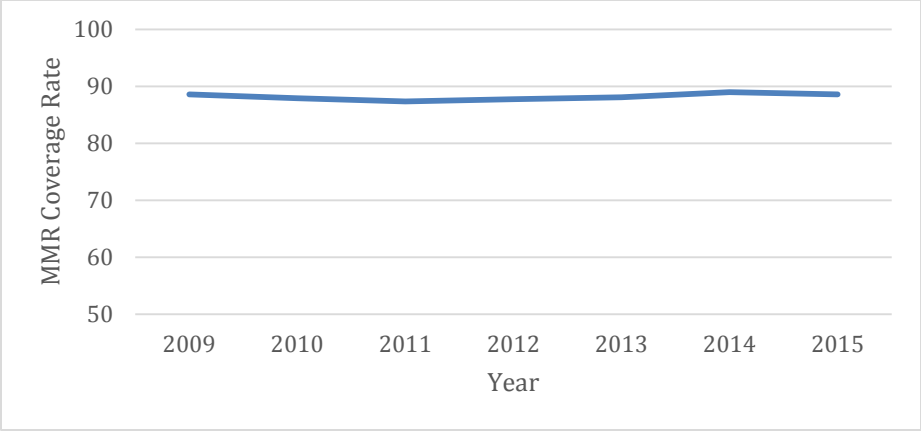


Figure 6-26: Edmonton one-dose by age-two MMR coverage rates between 2009 and 2015

	2009	2010	2011	2012	2013	2014	2015
Rates	88.59	87.90	87.34	87.75	88.09	88.96	88.59

Table 6-20: Edmonton one-dose by age-two MMR coverage rates between 2009 and 2015

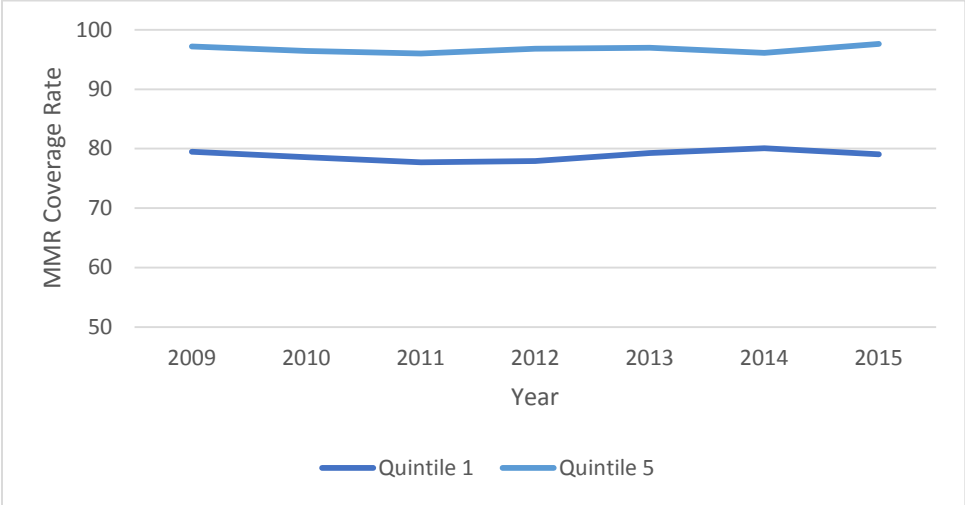


Figure 6-27: Edmonton one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood coverage quintiles

	2009	2010	2011	2012	2013	2014	2015
Rate Ratio	1.22	1.23	1.24	1.24	1.22	1.20	1.24
Lower Limit	1.14	1.14	1.15	1.16	1.13	1.12	1.24
Upper Limit	1.32	1.32	1.33	1.34	1.32	1.29	1.34

Table 6-21: Edmonton one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood coverage quintiles

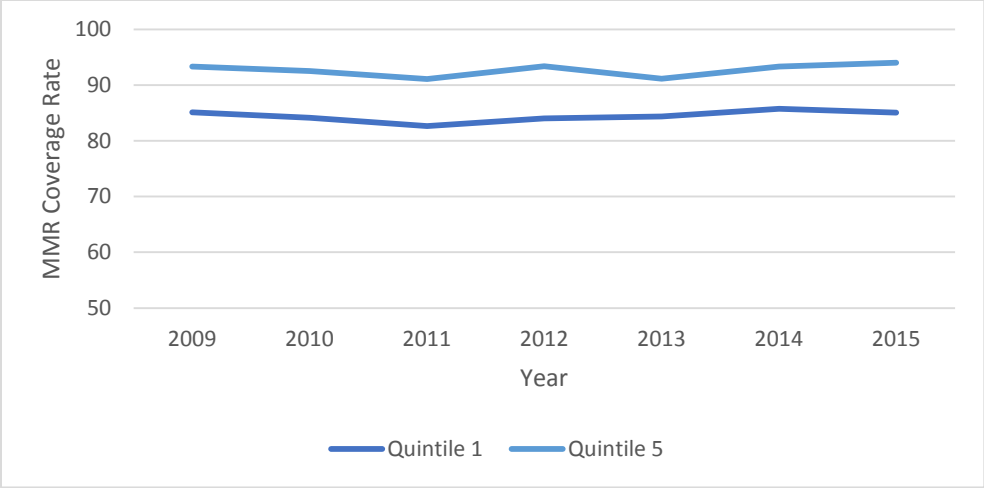


Figure 6-28: Edmonton one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood income quintile

	2009	2010	2011	2012	2013	2014	2015
Rate Ratio	1.10	1.10	1.10	1.11	1.08	1.09	1.11
Lower Limit	1.02	1.02	1.02	1.04	1.01	1.02	1.04
Upper Limit	1.18	1.18	1.18	1.19	1.15	1.16	1.18

Table 6-22: Edmonton one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood income quintiles

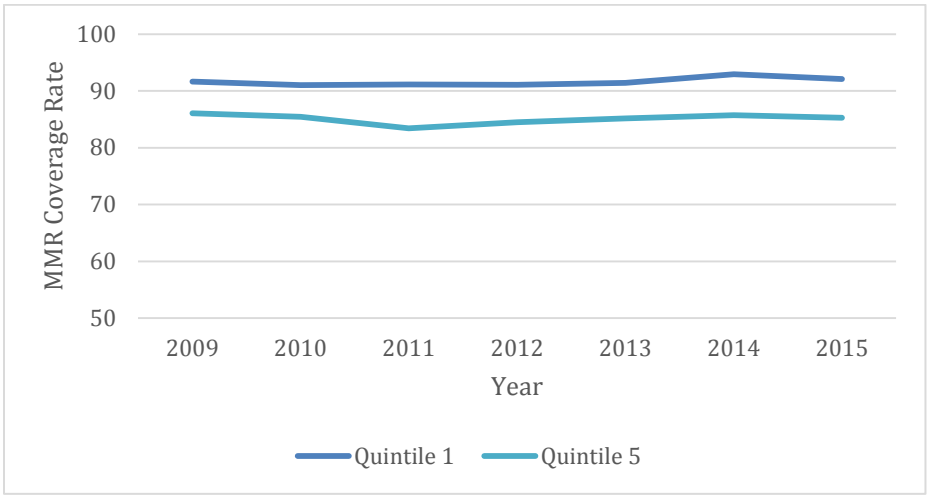


Figure 6-29: Edmonton one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood %-aboriginal population quintile

	2009	2010	2011	2012	2013	2014	2015
Rate Ratio	1.06	1.07	1.09	1.08	1.07	1.08	1.08
Lower Limit	0.99	0.99	1.02	1.01	1.01	1.01	0.01
Upper Limit	1.14	1.14	1.17	1.15	1.15	1.16	1.15

Table 6-23: Edmonton one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood %-aboriginal population quintiles

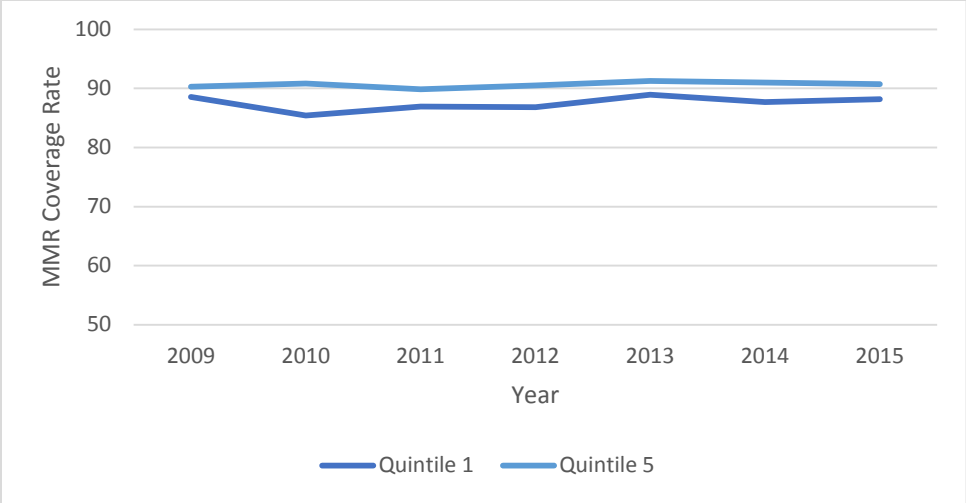


Figure 6-30: Edmonton one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood %-immigrant population quintile

	2009	2010	2011	2012	2013	2014	2015
Rate Ratio	1.02	1.06	1.03	1.04	1.03	1.04	1.03
Lower Limit	0.95	0.99	0.96	0.97	0.95	0.97	0.96
Upper Limit	1.10	1.15	1.11	1.12	1.10	1.12	1.10

Table 6-24: Edmonton one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood %-immigrant population quintiles

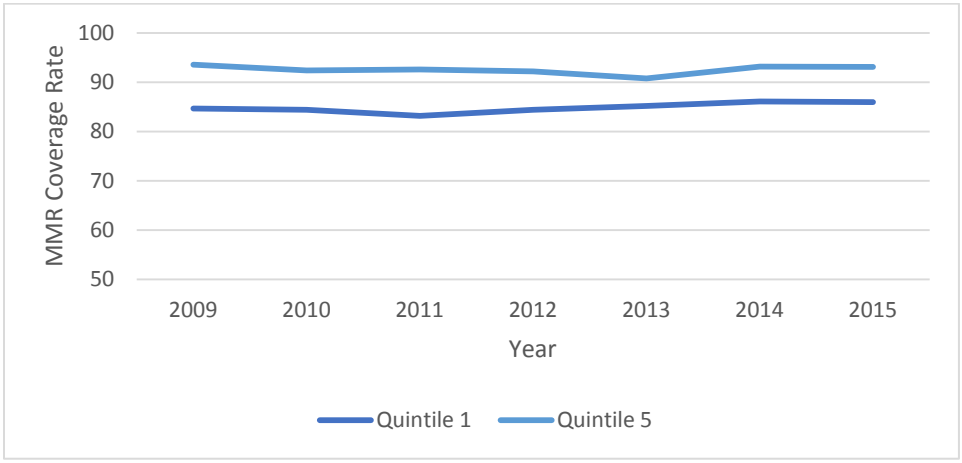


Figure 6-31: Edmonton one-dose-by-age-two coverage rates between 2009 and 2015, stratified by neighbourhood %-home-ownership quintile

	2009	2010	2011	2012	2013	2014	2015
Rate Ratio	1.10	1.10	1.11	1.09	1.07	1.08	1.08
Lower Limit	1.02	1.02	1.04	1.02	0.99	1.01	1.01
Upper Limit	1.19	1.18	1.19	1.17	1.15	1.16	1.16

Table 6-25: Edmonton one-dose-by-age-two coverage rate ratios and 95% confidence intervals between 2009 and 2015, stratified by neighbourhood %-home-ownership quintiles

Chapter 7 : Discussion

This discussion section is divided into within-case discussions and between-province discussions. Within case discussions provide a *synthesis and interpretations* of the case results individually presented above; the MMR immunization narratives of Saskatoon, Regina, Calgary and Edmonton. The between province discussions will provide a *synthesis and interpretations* of the MMR immunization narratives of Saskatchewan and Alberta during the study period. This is followed by an overall discussion section to summarize the learnings from all cases.

7.1 Within-Case Discussions

7.1.1 Saskatoon

Saskatoon experienced rising overall MMR coverage rates and persistent area-based geographic MMR coverage rate inequities, although the gap between the highest and lowest coverage rate neighbourhood decreased across the study period (RR^{range}= 1.20 - 1.36; $Rates^{bottom\ quintile}$ = ~69% to ~80%; $Rates^{top\ quintile}$ = ~93% to ~96%). When adding the area-based social determinants of health indicators to the analysis, the evidence shows clear coverage gap-reducing trends based on neighborhood income (RR^{range}= 1.22 in 2009 to 1.07 in 2015; $Rates^{bottom\ quintile}$ = ~75% to ~86%; $Rates^{top\ quintile}$ = ~90% to ~93%) and %-aboriginal population (RR^{range}= 1.14 in 2009 to 1.04 in 2015; $Rates^{bottom\ quintile}$ = ~78% to ~86%; $Rates^{top\ quintile}$ = ~89% to ~93%). Coverage rate gaps based on *neighbourhood income* showed the largest rate ratio magnitude among all years and stratifiers at 1.22 in 2009. The difference in coverage rates between the highest and lower income neighbourhoods went from statistically significant in 2009 to not statistically significant starting in 2012 and onward. All quintiles across all stratifiers increased absolute coverage rates over the study period.

The results indicate that the Saskatoon public health program has made purposeful steps to reduce neighbourhood childhood immunization coverage gaps by:

1.). Identifying the MMR coverage rates by neighbourhood and posting it in their office monthly

2.). Diagnosing the inequities in coverage rates by using area-based social determinants of health data and local front-line wisdom

3.). Using these data to design both unique targeted interventions, and targeted-adaptations to existing universal interventions.

Their interventions were mostly long-term programs and all the programs are built around geographic considerations. For example, the Building Health Equity Program continues to exist within the lowest-coverage neighbourhoods, deploying outreach workers (Community Program Builders) to residents in specific neighbourhoods. A consistently improving reminder-system is also central to their strategy, utilizing geographically-targeted autodialers based on monthly neighbourhood coverage rate reports.

The greatest gains for lower socioeconomic status neighbourhoods appear to happen between 2011 and 2012, as exhibited by the steep rise of all low socio-economic status quintiles, except in low %-homeowner neighbourhoods, which never exhibited an inequity during the study period. It was in between 2012 and 2013 that the high-socio-economic status neighbourhoods' coverage rates also rose, leading to a steep overall increase in gross coverage rates across the city. When combining the coverage data with the intervention timeline, it is clear in 2012 the noticeable rise in low-socio-economic status coverage rates is concomitant with the beginning of the highest intensity intervention period on the timeline. The cadre of interventions implemented after 2012 appear to benefit those in low income, relatively high-proportion Aboriginal, and relatively high-proportion immigrant, neighbourhoods. Overall, the interview data suggesting that the Saskatoon program utilizes evidence when considering the sources of their interventions (literature, lessons from pilots, conference, etc.) and their robust equity-based health data capacities inform their policy-making.

7.1.2 Regina

Regina experienced rising overall MMR coverage rates and persistent but reducing area-based geographic MMR coverage rate inequities (RR^{range}= 1.37 in 2009 to 1.22 in 2015; $Rates^{lowest\ coverage\ quintile}$ = ~68% to

~78%; Rates$^{\text{highest coverage quintile}}$ = ~94% to ~97%). When adding the area-based social determinants of health indicators to the analysis, the data shows clear coverage gap-reducing trends based on neighborhood income (RR$^{\text{range}}$= 1.26 in 2009 to 1.22 in 2015; Rates$^{\text{lowest income quintile}}$ = ~70% to ~80%; Rates$^{\text{highest income quintile}}$ = ~91% to ~94%), %-immigrant population (RR$^{\text{range}}$= 1.24 in 2009 to 1.01 in 2015; Rates$^{\text{lowest \%-immigrant pop quintile}}$ = ~70% to ~86%; Rates$^{\text{highest \%-immigrant pop quintile}}$ = ~83% to ~86%) and %-homeownership population (RR$^{\text{range}}$= 1.17 to 1.36; Rates$^{\text{lowest \%-homeownership pop quintile}}$ = ~68% to ~78%; Rates$^{\text{highest \%-homeownership pop quintile}}$ = ~90% to ~96%). The trend with regards to the %-aboriginal population stratifier is less clear; the trend shows reductions in inequities from 2009 (RR = 1.11) to 2012 (RR = 1.06), then back up for three years at an RR$^{\text{range}}$ between 1.11 and 1.16. There is also an anomalous regression towards increasing inequities in all indicators except %-immigrant population in 2014. I did not find a reason as to why this result occurred in 2014. Coverage rates across all the stratifiers showed an upward trend during the study period.

The results indicate that the Regina public health program is conscious of which areas of the city require the most attention in their efforts to reduce neighbourhood childhood immunization coverage gaps by:

1.) Identifying the MMR coverage rates by neighbourhood and posting their results monthly
2.) Diagnosing the inequities in coverage rates by through discussions about the low-coverage area-based at regular meetings those in the department
3.) Using these data, literature and lessons from the past to design interventions, wherever funds are available

Their interventions were mostly long-term programs, and much of their focus is based on a particular section of the city, where the specialized clinic conducts unique programming. There is also outreach being conducted, targeting both newcomers and at-risk youth mothers.

The greatest gains for lower socioeconomic status neighbourhoods appear to happen between 2010 and 2011. In this period, all the indicators showed steep gains. After this period, the most consistent

reductions in gaps were seen in relatively high-immigrant population neighbourhoods, though no quintile gets above 90% coverage. Overall, among the socio-economic status indicators, the largest persistent (but reducing) inequity is between neighbourhoods with the lowest homeownership rates and those with the highest homeownership rates. The %-homeownership graph most resembled the overall geographic inequities graph in both trends and magnitude. This indicates that areas of the city with the most renters are consistently not being adequately reached. This was a notable difference between Saskatoon and Regina, as Saskatoon did not exhibit inequities based on %-home-ownership.

The interventions targeting the lowest-socio-economic status areas appear to be resulting in reductions in neighbourhood MMR inequities over the study period. Overall, there is interview data suggesting that the Regina programs utilize their own and others' evidence in developing interventions and in their general public health practice, and they also use in-house population health data capabilities to assist in their public health policy-making.

7.1.2 Calgary

Calgary experienced relatively stable MMR coverage rates and consistent area-based geographic MMR coverage rate inequities throughout the study period (RR^{range}= 1.14 to 1.18; $Rates^{bottom\ quintile}$ = ~ 80% to ~ 83%; $Rates^{top\ quintile}$ = ~94% to ~96%). When adding the area-based social determinants of health indicators to the analysis, the evidence shows no statistically significant coverage gaps based on income, %-immigrant population, %-aboriginal population and %-home ownership, with an exception for %-homeownership in 2014 (RR = 1.07).

It is difficult to assess the effect of the explicitly equity-based interventions conducted just prior to the study period. It is possible that the relatively high absolute rates in Calgary during the study period may be the result of that pre-2009 IIF initiative being successful, but this conclusion is unlikely as multiple respondents mentioned that those funds ceased immediately after 2009, and unless all the practices that proved successful from that initiative were absorbed into day-to-day operations, the stoppage of those

funds would have probably resulted in a regression back to some lower and possibly more inequitable mean, which did not occur in the data.

Paradoxically, the results indicate that the Calgary public health program generally has not been targeted in their approaches to increase immunization rates over the study period. When they do conduct interventions, the following process is undertaken:

1.) Identifying the MMR coverage rates and other process-related indicators, by clinic
2.) Diagnosing any coverage deficiencies by using the above data and intra-and interdepartmental discussions to assess which clinics require solutions and why
3.) Using the data, evidence from the literature and/or suggestions from colleagues, designing interventions if funding is available.

The most significant epidemiological and policy-related event regarding MMR immunization in Calgary was the 2014 measles outbreak, where Calgary deployed more outbreak intervention resources than Edmonton. Indeed, 2014 showed the highest overall coverage rates of the study period at 90.77%. The epidemiological trend data suggests that this intensification of effort may have resulted in increased coverage rates for all neighbourhoods, with the implementation of the immunization outreach website (which did not appear to be specifically tied to the outbreak response) possibly also contributing. It is unlikely that the 2014 Centering-Parenting pilot contributed to increased rates because it only reached 40 families.

The data also suggests that the 2014 outbreak interventions may have preferentially reached higher socio-economic status neighbourhoods. When including all five quintiles in the income and %-homeownership related trend results, the quintiles align one to five, only during the year of the outbreak and response (2014). Considering neighbourhood income, quintile one to four are stacked in sequential order throughout the study period; it is only quintile five that was variably placed in the coverage ranking, until 2014. In 2014, quintile five suddenly surpassed all the other neighbourhoods in terms of rates for the first

and only time during the study period. With regards to %-homeownership, the one-to-five coverage gradient is a little more variable throughout, except in 2014, where, again, a true gradient emerges. The first figure below shows that the highest-income neighbourhood quintile made the biggest gains between 2013 and 2014 by a factor of 1.83 when compared to the lowest-income neighborhood quintile. The second figure below shows that gains were disproportionately made in the highest home-ownership neighbourhood quintile and the third home-ownership neighbourhood quintile. These results suggest that the intense interventions in 2014, at the least, disproportionately reached the highest socioeconomic status neighbourhoods when compared to the lowest socioeconomic status neighbourhoods. This 'self-sorting' phenomenon did not occur with the other socio-economic status indicators in 2014. These results suggest that the measures taken by AHS during the outbreak disproportionately reached higher income, and higher home-ownership neighbourhoods.

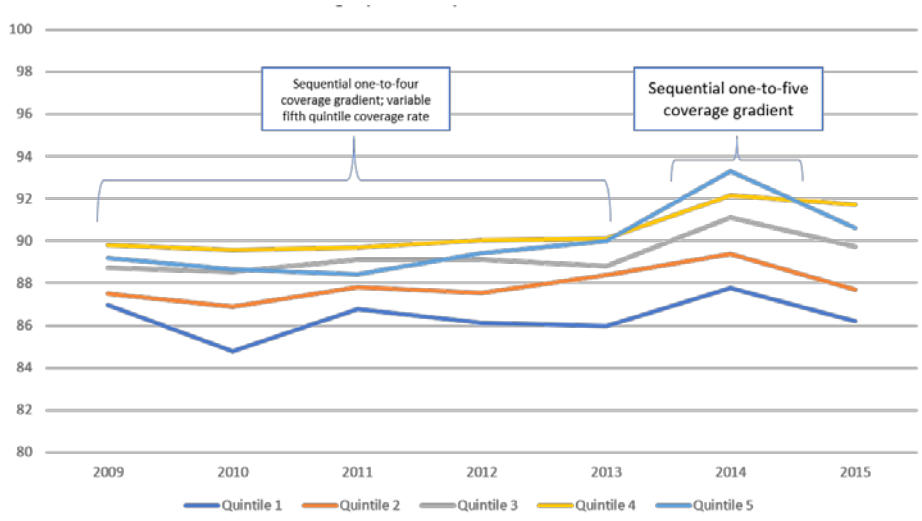


Figure 7-1: Calgary one-dose by age-two MMR coverage rates by income quintiles for 2009 to 2015

Income Quintiles	2013 MMR Coverage Rates	2014 MMR Coverage Rates	Rate Difference Between 2013 and 2014 MMR Coverage Rates
Quintile 5	90.01	93.30	3.29
Quintile 4	90.10	92.14	2.04
Quintile 3	88.79	91.11	2.32
Quintile 2	88.37	89.39	1.03
Quintile 1	85.97	87.77	1.80

Table 7-1: Comparison of 2013 and 2014 Calgary one-dose by age-two MMR coverage rates by income quintiles

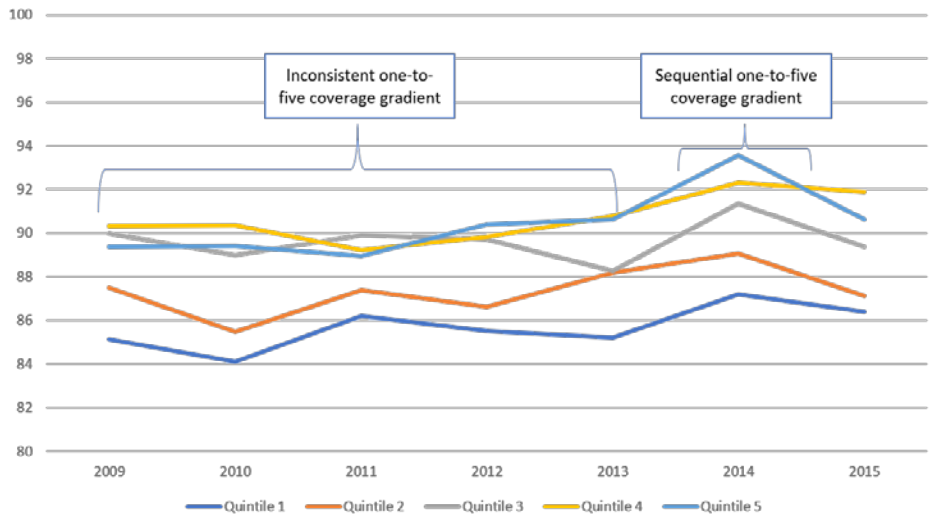


Figure 7-2: Calgary one-dose by age-two MMR coverage rates by %-home-ownership quintiles for 2009 to 2015

%-Homeownership Quintiles	2013 MMR Coverage Rates	2014 MMR Coverage Rates	Rate Difference Between 2013 and 2014 MMR Coverage Rates
Quintile 5	90.63	93.58	2.95
Quintile 4	90.78	92.31	1.53
Quintile 3	88.28	91.37	3.09
Quintile 2	88.20	89.07	0.87
Quintile 1	85.19	87.20	2.00

Table 7-2: Comparison of 2013 and 2014 Calgary one-dose by age-two MMR coverage rates by %-home-ownership quintiles

Overall, the results suggest that the Calgary public health program utilizes evidence in their policy-making process. This is clear in their use of literature and data in sourcing their intervention ideas, and their involvement in the extensive evidence-based work conducted at a provincial level. However, while their clinic-based coverage data capacities are strong, the interview data suggested that there does not seem to be consistent systematic equity-based data reporting processes informing their policy-making process.

7.1.3 Edmonton

Edmonton experienced stable MMR coverage rates and consistent area-based geographic MMR coverage rate inequities throughout the study period (RR^{range}= 1.20 to 1.24, $Rates^{bottom\ quintile}$ = ~78% to ~80%; $Rates^{top\ quintile}$ = ~94% to ~95%). When adding the area-based social determinants of health indicators to the analysis, the data shows inequities based on income (RR^{range}= 1.08 - 1.11; $Rates^{bottom\ quintile}$ = as low as ~84 to as high as ~86; $Rates^{top\ quintile}$ = as low as ~91% to as high as ~94%) and %-homeownership (RR^{range}= 1.07 - 1.11; $Rates^{bottom\ quintile}$ = as low as ~84 to as high as ~86; $Rates^{top\ quintile}$ = as low as ~90% to as high as ~94%) were consistent and statistically significant. No statistically significant coverage gaps were detected based on %-immigrant population or %-aboriginal population. As was the case in Calgary

as well, it is difficult to assess the effect of the explicitly equity-based interventions conducted just prior to the study period; whether the study period data represent a new baseline for Edmonton coverage rates after successful pre-2009 targeted programming, or if these were consistent with pre-2009 data trends.

Overall, the results indicate that the Edmonton public health program generally has not been very targeted in their approaches to increase immunization rates over the study period but do actively pursue opportunities given resources. When they do conduct interventions, the following process is undertaken:

1.) Identifying gaps in coverage through the use of in-house MMR coverage rates calculations by catchment area and/or through monthly discussions between the central public health office and representatives from the clinics

2.) Diagnosing the reasons for gaps by eliciting opinions from front-line practitioners and/or deploying surveys to assess the barriers for parents

3.) If funding permits, design pilots, utilizing intelligence from front-line professionals, colleagues, high-level meetings, literature, and conferences

Their “Health for Two” program is an ongoing and long-standing program within public health and provides targeted programming for high-risk mothers. This program’s capacity, however, is small as it operated with only four to five nurses at a time, and since it is highly targeted at individual mothers across the entire city, it is unlikely to be detected in a neighbourhood-level analysis.

The most significant epidemiological and policy-related event regarding MMR immunization in Edmonton was the 2014 measles outbreak, in which their interventions response was more attenuated than Calgary’s. Indeed 2014 showed the highest coverage rates in Edmonton over the study period at 88.96%. The epidemiological trend data suggests that the intensification of effort may have resulted in increased coverage rates for all neighbourhoods, with the implementation of the immunization awareness website (which did not appear to be specifically tied to the outbreak response) possibly also contributing. Edmonton’s 2014 response did not drastically disrupt socioeconomic gradients as happened in Calgary.

Overall, the results suggest that the Edmonton public health program utilizes evidence in their policy-making process. This is evident in their use of literature and consultation in sourcing their intervention ideas, as well as their involvement in the extensive evidence-based work conducted at a provincial level. However, there does not seem to be consistent systematic equity-based data reporting processes informing their policy-making process; their unit reported one socio-economic-based assessment conducted pre-2009 and sporadic need-assessment activities during the study period. It was reported that a more high-resolution reporting system initiative is underway.

7.2 Between-Provinces Discussion

Regarding Alberta, Edmonton and Calgary both exhibited similarly flat coverage trends within a ~4% margin. The difference in their absolute rates are the following: The lowest coverage rate quintile was lower in Edmonton (stayed around 79%) than Calgary (~79% in 2009; ~83% in 2015) and the highest coverage rate quintile in Edmonton (stayed around ~ 97%) was higher than Calgary (stayed ~94%). Both Albertan cases showed stable geographical neighbourhood-level inequities, and some evidence of marginal *socio-economically-linked* inequities. The intra-Saskatchewan public health programs are very similar in their absolute coverage rates *and* coverage trends in that the lowest coverage quintiles in Saskatoon and Regina start ~68% in 2009 and both ended up ~80% in 2015; and the highest coverage quintile in both cases started ~93% and both ended ~96%. Both Saskatchewan cases showed neighborhood-level inequities across a majority of the socio-economic stratifiers.

The similarities in absolute rates and rate ratio trends intra-provincially appear more significant than the differences inter-provincially, suggesting that there may be provincial factors influencing MMR immunization public health practice. The key difference between provinces is that both Saskatchewan cases reached a coverage rate by 2015 (80% to high-90%) that Alberta cases had already achieved by 2009 (and stayed at until 2015). This data suggests that, at a neighborhood level, Calgary and Edmonton

public health programs were more effective, sooner, at delivering first-dose MMR immunizations at a neighborhood level than Saskatoon and Regina. It is important to reiterate that while Calgary and Edmonton both *started the study period* at high rates (80% to high-90% range for each), there were no sustained gains (largely flat trend) made within the study period. Further research would provide insights into if these 80% to high-90% neighborhood-level rate ranges represents a type of limiting threshold at which urban centers maximally achieve. This can be assessed by analysing other urban centers, using the same methodology, to detect if narrower neighborhood-level coverage gaps *can* be achieved.

The comparatively high Albertan averages compared to Saskatchewan may be due to several factors. Firstly, when comparing the Ministry-level policy data between Alberta and Saskatchewan, the Alberta provincial Ministry of Health showed much more childhood immunization research and policy-making activities than their Saskatchewan counterpart around and during the study period. The Alberta activities included the investment of $8 million dollars towards the "Innovations in Immunization Fund" initiative, the release of the *Alberta Immunization Strategy 2007-2017*, deployment of the outbreak resources in 2013, and the provincial immunization research presented at (and the hosting of) the 2014 Western Canada Immunization Forum. Also, because the Alberta health authority is centralized, and as evidenced in the interview data regarding the consistent Albertan interprovincial immunization meetings, it is likely that *centrally-produced* MMR coverage-related policy and programming information were conveyed consistently between Calgary and Edmonton, resulting a better coordination of policy and programmatic innovations between the centers. Indeed, the outbreak-related immunization programming that was mandated *provincially* showed a noticeable, coordinated impact in both Edmonton and Calgary coverage rates simultaneously.

While the Saskatchewan Ministry provides clinical policies regarding the immunization scheduling, immunization targets, and the short passage on possible interventions for improving immunization rates in their *Guidelines*, there is overall a lack of a provincial immunization strategy, research, or

programmatic coordination originating from the Ministry. Instead, what appeared to happen was that the well-publicized Saskatoon-based research into general health inequities (2008 report), and initiative towards closing immunization gaps in 2007, and other national inequities research may have influenced the Regina center to intensify closing their coverage inequity gaps as well; the Saskatoon-based work representing a policy-leading approach for other sub-provincial public health actors to move forward with equity-based policies and programs.

The provincial childhood immunization-related activities conducted by the Alberta Ministry of Health signal that immunization was also *a priority* at a provincial level during the study period. Over the same period, the Ministry of Health in Saskatchewan signaled that their priority, on the other hand, was the elimination of overall health system waste with the implementation of the 'Lean' initiative. This suggests that at a provincial level, Alberta had a more favorable environment for immunization-related policy and programmatic innovation; that childhood immunization was a clear agenda for the province. Notably, the results suggest that by 2009, with a few exceptions, the Albertan cases did not indeed seem to *require* any drastic programmatic or policy changes to achieve largely equitable neighborhood rates. Alberta's urban childhood immunization infrastructure at its 2009 baseline already appeared to be reaching children more equitably, and at higher rates, than the Saskatchewan cases, at least at a neighborhood level. The largest Albertan exception was the inequitable stratification after the response to the outbreak (2014) in Calgary. This distinct event itself provides insight into another aspect of provincial immunization policy-making: an inequitably designed Albertan emergency immunization program.

7.3 Overall Discussion

7.3.1 Which urban public health units have reduced MMR coverage inequities in the Canadian Prairies?

The MMR coverage rate trend data in these four cases must be analyzed in both absolute and relative terms. Firstly, it is important to note that no jurisdiction reached one-dose MMR herd immunity coverage rate levels of 98% coverage at any period in the study. In absolute coverage rate terms, Saskatoon and Regina were performing relatively poorly at the beginning of the study period and improved to Calgary and Edmonton coverage levels by the end of the study period. Calgary performed the highest consistent overall absolute coverages rates, followed by Edmonton, Saskatoon and Regina, with all the cases being much more similar intra-provincially than inter-provincially. Table 35 summarizes the results, ranking them by coverage rate at the end of the study period (2015), and their trajectories over the study period. Of note is Saskatoon's performance, ending the study with the distinctions of having the highest overall coverage rate and being the most improved.

Cities	2009 coverage rate	2010 coverage rate	2011 coverage rate	2012 coverage rate	2013 coverage rate	2014 coverage rate	2015 coverage rate	Ranking by coverage rate at end of study period (2015)	Trajectory of coverage rates
Calgary	88.51	87.7	88.37	88.43	88.68	90.11	89.15	Second-Highest	Stable
Edmonton	88.59	87.9	87.34	87.75	88.09	88.96	88.59	Third-Highest	Stable
Saskatoon	82.38	84.7	84.08	85.72	88.74	88.77	89.96	Highest	Most-Improved
Regina	82.25	82.3	84.16	85.01	86.37	85.71	88.42	Fourth- Highest	Second-Most Improved

Table 7-3: MMR coverage rates trends in Calgary, Edmonton, Saskatoon and Regina between 2009 and 2015

When considering the trends from an equity perspective, the story is slightly different. The fact that there is an inequitable spread and/or uptake in public health immunization services within the case cities *at all*

suggests that the four public health systems in this study are not consistently meeting the needs of all children equally. The quantitative results show the systems did discriminate (show statistically significant differences) coverage rates:

a.) By **neighbourhood geography** across **all cases**

b.) By **neighbourhood income** in **most cases** (Edmonton to the greatest extent, then Regina, then Saskatoon)

c.) By **%-homeownership** in **half of the cases** (Regina and to a lesser extent, Edmonton)

d.) Marginally, by **%-Aboriginal only in Regina** in **2014**

e.) By **%-immigrant only in Regina** and only in **2009**

It also shows that Saskatoon and Regina worked to reduce their inequities to levels of statistical insignificance generally; to a level that Edmonton did not, and Calgary did not have to.

The table below shows a summarized qualitative assessment of "severity of inequity" and "trajectory of inequity" of the cities between 2009 and 2015. The rate ratio magnitudes and trends were both considered per stratifier and compared between cities when assessing relative severity.

	Geography		Income		%-Homeownership		%-Aboriginal		%-Immigrant	
	Severity of inequity during the study period	Trajectory of inequity	Severity of inequity during the study period	Trajectory of inequity	Severity of inequity during the study period	Trajectory of inequity	Severity of inequity during the study period	Trajectory of inequity	Severity of inequity during the study period	Trajectory of inequity
Calgary	*	Stable	-	Stable	-	Stable	-	Stable	-	Stable
Edmonton	****	Stable	**	Stable	**	Stable	-	Stable	-	Stable
Saskatoon	**	Second-Most-Improved	***	Most-improved	-	Stable	-	Most-Improved	-	Stable
Regina	***	Most-Improved	****	Stable	****	Stable	-	Stable	*	Most-Improved

Table 7-4: MMR coverage rate inequities ranked by severity and stability in Calgary, Edmonton, Saskatoon and Regina

It is clear that none of the public health programs in the case cities successfully reached all neighbourhoods equitably; the lowest coverage quintiles are consistently statistically significantly lower compared to the highest coverage quintiles. This indicates that the range of coverage rates *may be* improved such that this difference is statistically insignificant. Other cities in Canada may be performing to a level where the range is statistically insignificant. Calgary performed exceptionally well among the case cities; followed by Edmonton, Saskatoon and Regina. The stratifier that showed the most consistent statistical significance overall were coverage quintiles (all cities) and income (all cities except Calgary). The stratifier that showed the most dramatic influence (highest reported statistically significant rate ratios) apart from geography, was %- homeownership in Regina (RR^{range} = 1.19 to 1.36).

7.3.2 Which interventions and/or policies have worked to reduce inequities and where?

Saskatoon and Regina were the two cases in which inequities were reduced over the study period, while Edmonton had persistent inequities at high coverage rates, and Calgary showed only geographical inequities while also exhibiting high coverage rates. In terms of "what worked" in among these cases, some key lessons emerged. These lessons can be organized into two categories, representing two levels of public health practice: *Contextual* and *Operational*. *Contextual* lessons are those that describe the mediating factors that affect how public health activities are deployed. In this case, context is more specifically described through synthesizing: a) the financial aspects of public health practice; and b) the policy structures and conditions that public health programs are subjected to. The *operational* lessons can be described by explaining the findings associated with the three-phase WHO TIP policy process framework. By analyzing the policy data through this framework, the successful practices observed across the case studies can be organized into actionable best-practices to be replicated and pursued further. The figure below shows a visual representation of how the answers to this research question are organized in the subsequent sections:

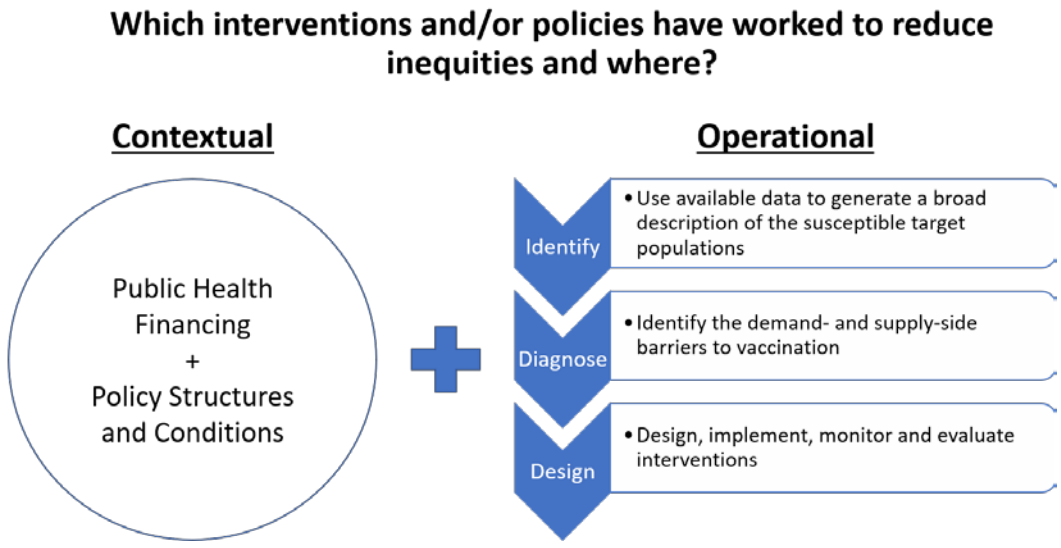


Figure 7-3: Diagram summarizing research question #2 discussion

7.3.2.1 Contextual

7.3.2.1.1 Public health financing

All cases reported that targeted interventions to increase immunization rates require *extra* capital and human resources in already-tight public health budgets. These costs were specifically cited in terms of compensation for nurses and costs associated with program materials and training. Inconsistent access to necessary extra funding was cited specifically in Alberta as a barrier to further targeting programming.

The lack of adequate funding for public health overall, as it is in all health-care financing, is a perennial issue. CIHI data reports that public health financing is not immune to the intense scrutiny of health costs control measures: between 2014 and 2017 public expenditure on public health went from 5.6% of total health expenditures in Canada to 5.5% (Canadian Institute for Health Information, 2016, 2017). Hemenway (2010) suggests that in the United States, a retrenchment of public health resources is not only dangerous to society, it is predictable due to non-personalized, politically unpopular long-term nature of up-front investment into public health interventions. In the UK, public health budgets are reportedly considered a "politically soft target", especially after the 2008 global financial crisis (Masters, Anwar, Collins, Cookson, & Capewell, 2017). These overall cost pressures combined with the growth of number of vaccinations given, and population growths reported by participants in each of their jurisdictions, represent a cost- and human resource-limited environment in which it is difficult to divert resources towards targeted projects.

Public health also has a broad mandate, and as such, leadership must decide on prudent *internal* resource allocation as well; how to maintain all public health programs utilizing a finite amount of resources. It was especially apparent in Calgary that though immunizations were operationally becoming more resource intensive due to increasing number of immunizations and population growth, there was not a concurrent increase in resource allocation dedicated to immunizations. The maintenance of high immunization rates during the study period in the Calgary case may have, therefore, come at the expense of other internal public health responsibilities, which could mean less resources for health promotion or

environmental health activities, for example. A further analysis into other health outcomes could reveal if other public health measures were affected during the same period.

Regarding immunizations specifically, it is important to note that the evidence is overwhelming that well-designed immunization strategies are largely cost effective, albeit on a spectrum (Busby, Jacobs, & Muthukumaran, 2017; Jacob et al., 2016; Szilagyi et al., 2002) - reminder systems are generally the cheapest interventions, and complex combined interventions are the costliest. MacDonald summarizes the cost effectiveness research from the National Institute for Health and Clinical Excellence regarding MMR immunization by stating that whether a public health program were to increase rates in groups with low coverage rates or among those with already high coverage rates, or even use the highest cost interventions like home visits, "almost any method of increasing coverage would be cost effective" (Macdonald, 2016, p.254).

There exists, however, a complicated relationship between cost and specifically *equity-related, targeted* programming. Cookson et al. (2017) suggest it is indeed possible for equity-oriented programming to be cost-effective, existing in the First "win-win" Quadrant of their Health Equity Impact Plan (Figure 7-4), where an intervention may be both cost-effective and reduce inequity. They suggest that immunization and other similar preventative interventions are examples of these. But at the same, no matter how cost-effective an intervention is, *access* to an overall cost-effective intervention may be not be equal among social groups. To remedy this, they suggest that policy makers *redesign* delivery strategies to "increase utilization and quality in disadvantaged communities" (Cookson et al., 2017, p.208) wherein they may have to conduct less cost-effective practices compared to standard strategies, resulting in a Quadrant IV "lose-win" scenario.

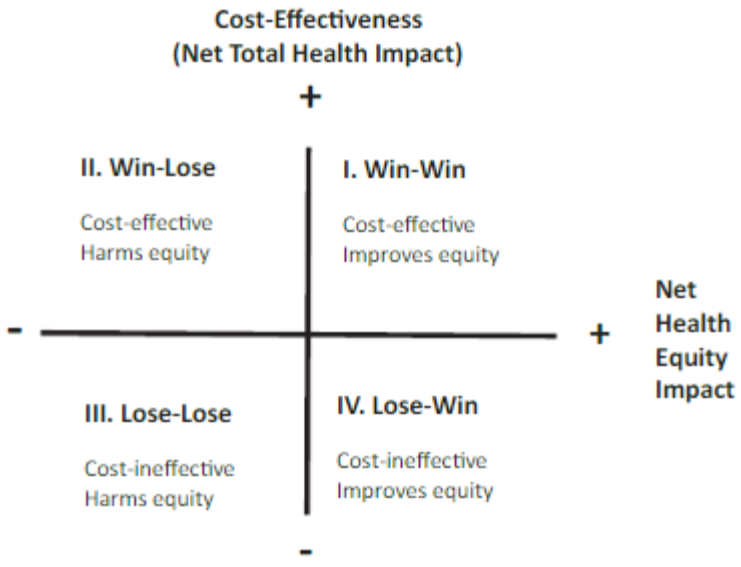


Figure 7-4: Health equity impact plane reprinted from Cookson, R., Mirelman, A. J., Grif, S., Asaria, M., Dawkins, B., Norheim, O. F. … Culyer, A. J. (2017). Using Cost-Effectiveness Analysis to Address Health Equity Concerns, 20, 206–212. https://doi.org/10.1016/j.jval.2016.11.027. Creative Commons 4.0.

This *redesigning step* appears to be where the cost considerations of the study cases emerges, especially in an administrative structure that may already be resource-tight and consider targeted programming as added work on-top-of standard practices. This type of cost appears to be why among the cases, grant-money - that is to say, extraneous money on-top of the regular operating budget - is required to conduct equity-based interventions. In Saskatoon's case, the 2007 CIHR grant to specifically conduct equity-based immunizations interventions began their equity-based practice thereon in, while there is less evidence to suggest that the Albertan IIF grant funding did the same. As to why the pilot in Saskatoon was integrated into standard practice and the Albertan IIF interventions were largely not, is a question worth investigating further.

7.3.2.1.2 Policy structures and conditions

The critical realist perspective of causation in this natural experiment paradigm guided the assumption that the institutional public health *structure* and inner and external policy *conditions*, through policy interventional *mechanisms*, will yield MMR coverage rate *effects*. The *effects* in these cases (trajectories

of coverage rates) unfolded differently from each other largely by *province*, and thusly, necessitate unique provincial explanations to the question "What worked to reduce inequities, and where?".

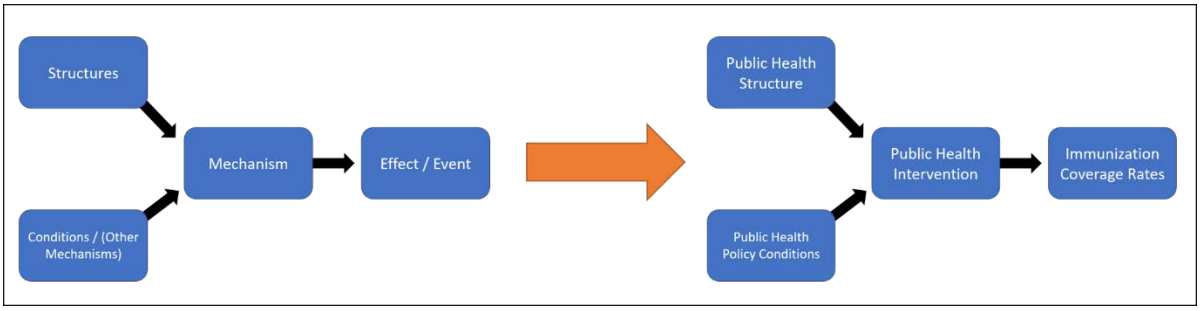


Figure 7-5: Critical realist epistemology in general and its adaptation in this study

The relatively high performance of the Alberta cases suggest that the Albertan public health program *structure* and the Albertan public health policy *conditions* were likely influential to their overall performance. As mentioned before, the data shows that there are marked distinctions in each province's public health *structure* and *conditions* over the study period that are worth exploring.

7.3.2.2 Structure

There is an ongoing discussion among academics and policy-makers about what the optimal public health system *structure* is, specifically in terms of whether centralized or decentralized models deliver the most effective services. Several documents (Hyde, 2009; Leider, Resnick, Bishai, & Scutchfield, 2018; Stoto, 2008; Wasserman et al., 2006) outlining the state of public health organizations in the United States describe an inconsistent system with varying levels of public health capacities across the country. While public health agencies are often organized at the county or municipal level, and receive funds from federal, state and local taxation revenues, the United States overall "has no coherent system of Government funding of public health", (Leider et al., 2018, p.472) where the structural arrangements of agencies are entirely dictated by the idiosyncratic regulations and laws of each state (Leider et al., 2018). In Canada, the conversation is also ongoing. Most recently, the Ontario provincial expert panel on public health's report (2017) calls on a further redistricting of public health boundaries, from 36 public health units to 14, to improve service delivery capacity parity between jurisdictions.

The reported possible benefits of decentralized governance of health services overall are described by Sreeramareddy & Sathyanarayana's Cochrane review (2013) on the topic, include better local responsiveness, less bureaucracy and more local empowerment. The downsides include the lack of resources available to smaller centres, subsequent increased workload and burnout and lack of personnel retention. Smaller centres may also lack management capacity and adequate accountability structures (Minister of Health and Long-term Care Expert Panel on Public Health, 2017; Sreeramareddy & Sathyanarayana, 2013).

Alberta's system, while heavily centralized, still utilizes local representatives to carry out services in "zones", in which Edmonton and Calgary exist in their own zones. The centralized elements of their system enabled the provincial input into policy-making in both Calgary and Edmonton, and the provincial mobilization of resources during the outbreak. The centralized structure also ostensibly made it easier to translate *the Ministries' priority* of improving childhood immunization coverage into improvements in service delivery by Alberta Health Service in the province as whole. The Saskatchewan data revealed a much more decentralized provincial public health structure. While high-level clinical guidelines and targets are signalled by the provincial Ministry of Health, there is very little centralized input into local public health programming overall. With Saskatchewan moving towards a central health services authority in 2017, further research will reveal if this move improves public health programming and policy coordination provincially.

7.3.2.3 Conditions

The differing provincial policy *conditions* during the study period are also important to consider. As mentioned before, the Alberta policy data suggested that there was substantial political and policy activity around the topic of childhood immunizations - the most significant being in 2007 with the launch of the Alberta Immunization Strategy 2007-2017 platform and the IIF funding initiative. The sustained policy and political effort thereon, exhibited by the research presented at the Western Immunization Forum, and the outbreak activity, signalled that childhood immunization coverage was on the agenda in Alberta.

Conversely, the environment was slightly different in Saskatchewan, where the agenda was more about quality improvement overall with the introduction of the Lean program, with strong local interest in equity. It is then not surprising to consider that in Saskatchewan, an *improvement- and equity-based* culture coalesced into the *equity-based improvements* in their immunization rates.

There is no clear data to suggest that immunizations merely being politically top-of-mind led to any long-term programming changes in Alberta. On the contrary, both Alberta cases reported that resources were not particularly plentiful for the cause. However, again, their overall high-performance does suggests there were effective policies and programming already in place by 2009, but this study did not find data to explain what those elements were.

The policy events in Saskatchewan during the study period do point towards a policy-based phenomenon familiar to the policy literature. The improvements in both absolute and equity-based relative immunization rates in Saskatchewan can be explained by Kingdon's Three Stream Policy Window Model (Kingdon, 1984). Kingdon described three streams of concepts - Problems, Policy and Politics - that, while usually running in parallel over time, crossover at specific times (windows), to initiate policy change (Figure 7-6). The "problem stream" describes the specific issues that exist in a system, the "policy stream" are solutions to problems that exist in the world, and the "politics stream" involve political actors and institutions and their willingness to dedicate resources on any given problem.

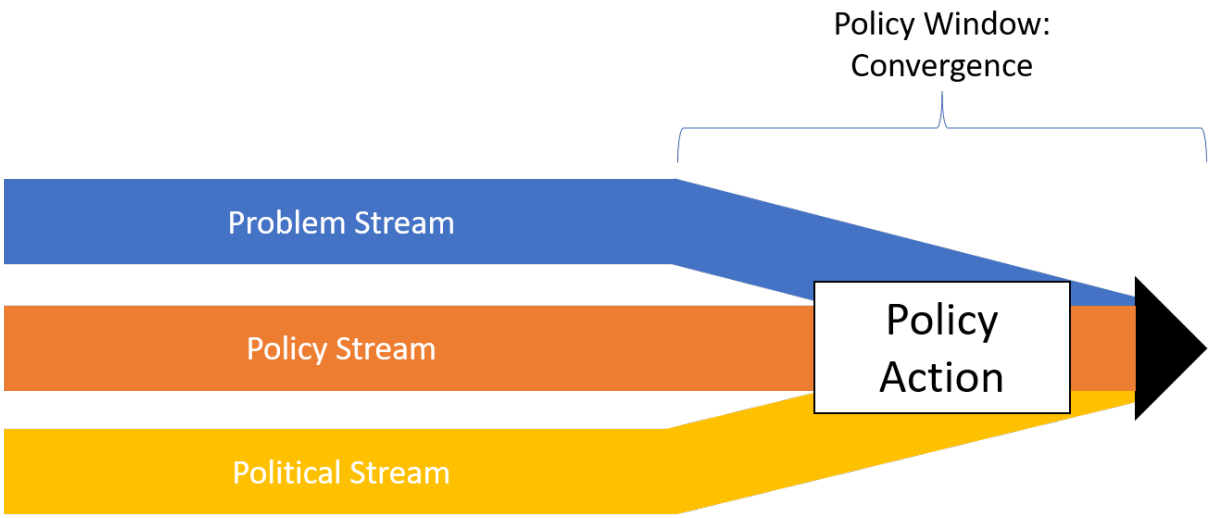


Figure 7-6: Kingdon's three stream policy window model

In Saskatchewan, I propose that the study period represents a window where these three domains coalesced, which led to action on improving immunization coverage. Kingdon states that the problem needs to firstly exist and be well described. The 2007 CIHR childhood immunization intervention study and the 2008 report on health inequities primed public health officials to the *problem of health and immunization coverage inequities* with clear epidemiological evidence. The *policy stream* was subsequently being cultivated by the same problem-defining research. The policy stream is also highly informed by the evidence elsewhere (literature, online, etc.) that already may have existed around improving immunization rates in other jurisdictions. Actors in the *political stream* (politicians, decision-makers within health care, community organizations) were both informed by the controversial findings of the 2008 inequities report by reportedly being *included* in pre-launch discussions (The National Collaborating Centre for Determinants of Health, 2012) and were heavily dedicated towards their massive investment in their Lean quality improvement in health care initiative, all within the study period. Also of note is that the "problem" of health inequities was discovered by actors *within the health care system* (from public health) instead of from an outside organization (academia, non-profit, etc.), which, in a publicly funded system, inevitably implicates governmental actors. This could also have influenced the "political" stream.

With regards to the "political" stream specifically, an important distinction must be made between what I will refer to as big "P" politics and little "p" politics. In Saskatchewan, the big "P" political players involved in health care and public health include those at the *provincial ministry* level – elected officials affiliated with a major political party, and the ideological policies they implement. The small "p" politics in Saskatchewan involves sub-government actors including those within the Saskatoon Health Region, community organizations, and municipal government – those who are not involved directly in political-party based power relations with public health but have decision-making power in local jurisdictions. Kingdon's definition of politics indeed includes both: "The political stream comprises factors that influence the body politic, such as swings in national mood, executive or legislative turnover, and interest group advocacy campaigns." (Kingdon's definition as described by Béland & Howlett, 2016, p 222). While the Saskatchewan Conservative provincial government at the time were not particularly equity driven, as evidenced by, for example, their ceasing of funding for a core neighbourhood social services facility in 2008 (CBC, 2008), they were reported to be a centre-right party, generally avoiding "bold ideological gestures" (Béland 2011). Amongst this centre-right big "P" political climate, the case study published on Saskatoon regarding this period (2012) suggest that while big "P" bureaucrats were involved, there was particularly strong attention paid to the small "p" politics, overall, of the issue:

> "The Saskatoon Health Region presented the data from the Health Disparity report to Saskatoon's Regional Intersectoral Committee. This 30-member committee had representatives from four municipal departments, seven provincial ministries, two federal agencies, researchers, Aboriginal organizations and a dozen community-based groups. All were senior members of their organizations, with decision-making powers.
>
> …Rather than get defensive and question why the health region was finally getting involved in these critical issues, the community took the opportunity to learn about the data before it was publicly announced. Many appreciated the request to help Saskatoon Health Region communicate

> the results effectively. Most importantly, community members expressed a desire to move ahead and get on with solutions." (NCCDH, 2012, p 6)

On its face, the small "p" politics of the issue of action on health inequities appears to be in tension with a centre-right governmental ideology. In this case, however, the regional health authorities responsible for public health practice may have been distant enough away from the centre-right big "P" politics of the provincial government to not have been beholden to their ideology, enough so in fact that a small "p" mobilization may have proven to be the more influential animating force behind the movement on the health equity agenda.

It is important to emphasize that the media can also affect the "problem" and "politics" streams in that they can influence the narrative of what constitutes a public problem and can inform the electorate (Larkin, 1996). Indeed, in a media coverage content review by the NCCHPP for 2008 - a reported banner-year for health inequities as it marked the release of the WHO Commission on the Social Determinants of Health report and several national reports and meetings on the topic - the *Saskatoon Star Phoenix* was second to the *Toronto Sun* in national coverage of health inequities nationally, due to the released of the *Health Disparities in Saskatoon* report. The local Saskatoon CBC also reportedly released a weekly mini-documentary about the social determinants of health (The National Collaborating Centre for Determinants of Health, 2012). The *Leader-Post* (Regina) was also reported as among the most interested media outlets in the WHO report and the Saskatoon-based report. This heavy media attention on health inequities in Saskatchewan suggests that the conditions were appropriate to politically supercharge the issue of health inequities, making public health mobilization towards reducing health inequities more politically-palatable, in which immunization coverage inequities were addressed. In the end, while the immediate reaction to the reporting was reportedly "mixed" among those *affected by* these inequities, the NCCDH reports that concrete steps have been made in Saskatoon to move towards health equity, including the formation of an intersectoral poverty reduction partnership, improvements to provincial income-supports, and the health region adopting "health equity" as an organizational priority (NCCDH, 2012).

According to Kingdon, the convergence of the streams may be due to chance, political cycles, organizational turnover or the result of 'policy entrepreneurs': Individuals whom are "willing to invest their resources in return for future policies they favour" (Exworthy, 2008, p.322). In the Saskatoon case, it is reported that that the health inequities problem was acted on through demonstrated leadership by public health policy entrepreneurs. The 2012 case-study (NCCDH, 2012) reports that it was public health professionals who conducted the research, engaged community partners prior to launch of the report, and carefully planned the messaging of the launch, which fostered a favourable environment for the streams to align during the study period.

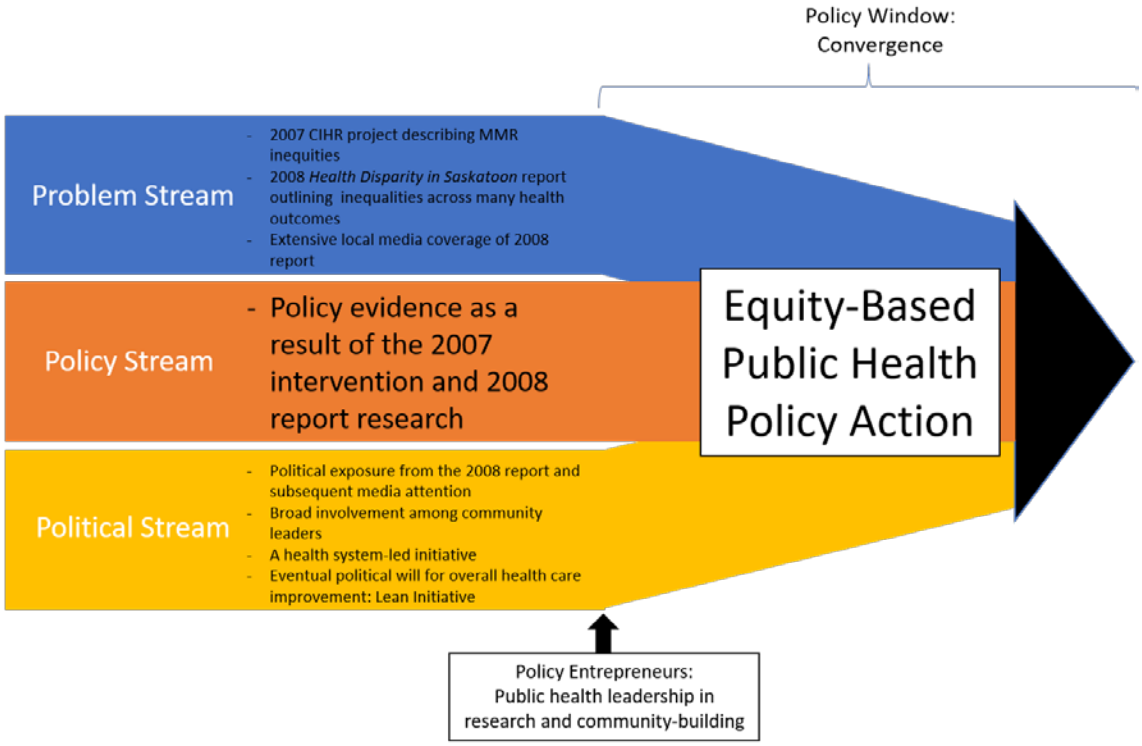


Figure 7-7: The Saskatoon case study adapted in Kingdon's three stream policy window model

This streams model is often cited in health inequities and public health literature in general (Brownson et al., 2009; Carey & Crammond, 2015; Exworthy, Berney, & Powell, 2002; Mannheimer, Lehto, & Östlin, 2007; K. E. Smith, 2007; Strand & Fosse, 2011) and is highly informative for those who want to shape public health policy. The PHSSR and PIHR research enterprises are wholly responsible for the "policy"

stream itself by contributing the knowledge of "what policies work" to reduce inequities. It is then up to policy entrepreneurs to capitalize on this intelligence. The "problem" stream appears to be the responsibility of the public health units themselves; public health problems within any given jurisdiction can be well described through rigorous *local* surveillance. While large urban centres may have the resources to do this, this is an ongoing issue for those smaller public health units that may lack surveillance capacity. Immunization data sharing between public health units may help alleviate the analytical burden from smaller centres, allowing high-capacity units to analyze and disseminate data across jurisdictions in a province, for example.

The *politics* stream, however, appears to be a particularly difficult piece of the public health research puzzle to describe. Though a few recent strides have been made in the literature toward blending political science and public health research (Brown, 2010; de Leeuw, Clavier, & Breton, 2014; Fafard, 2015), the relationship between the two fields is described by Gagnon et al. (2017) in tenuous terms: "Public health researchers often criticize political scientist for being too "theoretical" in their approach. Political scientists, on the other hand, often consider public health researchers as having a "naive understanding of political reality" (p. 495). Gagnon et al. suggest that progress on a collaborative research agenda will take improving our knowledge around the political contexts of society, exploring in detail the functions of public health across levels, evaluating public health policies rigorously and conducting comparative analyses across jurisdictions. In the Saskatoon case, the difference between the big "P" and small "p" politics is an important *contextual* political element to consider. Health inequities can be a particularly politically unpopular topic for any politic involved; the messiness of the power dynamic at any given time requires a careful audit of who may or may not have influence on the policy entrepreneur, to move the agenda forward.

7.3.2.2 Identify

The following discussion is framed around the "Identify" domain of the WHO TIP policy process, and will report how the case public health programs used data to understand firstly the state of immunization coverage, and secondly, where the coverage gaps are in their jurisdictions:

7.3.2.2.1 Spatial epidemiology and geographical targeting

As the programs that did the most improving, Saskatoon and Regina both took a deliberative approach to *identifying* target populations by specifically using spatial epidemiological approach. These data went on to inform the rest of the steps of their childhood immunization policy process by focussing their efforts geographically.

Dummer (2008) argues that macro-phenomena such as urbanization and spatial polarization among citizens necessitate the prudent use of health geography in public health policy making, especially in detecting and addressing social and spatial inequities in health. CIHI and their Canadian Population Health Initiative (2018) also advocate for the use of geographic-based epidemiology, describing it as "a promising tool for providing multidimensional, easily accessible and meaningful information for policy- and decision-makers."

In this vein, Maravi et al. (2017) show that using spatial analysis for a pertussis immunization coverage rates intervention provided the Colorado Department of Public Health and Environment a data-informed geographical model for where to cost effectively conduct targeted interventions. Similarly, Stopka (2014) reported utilizing a geographic information system and cluster analysis to target their California-based Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) Program. They specifically outline that their geographical analyses were presented to directors, staff, health care providers and stakeholder groups to guide policy decision-making.

The geographic data that Saskatoon and Regina used not only provided them with spatial information but were linked with descriptive socio-economic and/or front-line wisdom about the actual *neighbourhoods* and *elements common among the people within them* in particular. Leveraging contextual geographical

data is common among health entities in Canada (Alberta IHDA, 2018; Manitoba Health Seniors and Active Living, 2018; Nova Scotia Health Research Foundation, 2018; Public Health Ontario, 2018; Vancouver Coastal Health, 2018) and is also widely reported in the Canadian health inequities literature overall (Buajitti et al., 2018; Pampalon, Hamel, & Gamache, 2010; Public Health Agency of Canada, 2018). Indeed, one could argue that epidemiology was firstly a contextually-driven, geographically based science, back to the works of Dr. John Snow in 1865. Saskatoon and Regina are among a long lineage of jurisdictions to use rich socio-economically linked spatial data, providing insights into the populations within these neighbourhoods, and constructing spatially-based policy heuristics with which to decide where to target appropriate services. Calgary and Edmonton not reporting the use of geographically-based data as extensively as their Saskatchewan counterparts suggests that there is a *provincial difference* in public health data practices.

Maps have been used to inform the practice of those outside of the health sector as well. Public health in Montreal and Saskatoon leverage two particular initiatives, “Espace montréalais d'information sur la santé” (EMIS) and “Community View Collaboration”, respectively, to help drive intersectoral collaboration. These web-based data visualization interfaces report public health, social determinants of health and local services data to be utilized by decision-makers, researchers and the public (Canadian Council on Social Determinants of Health, 2014). Combining data from public health agencies, academic institutions, governments (provincial and municipal) and non-governmental organizations allows these tools to be relevant to as many social and health-interested parties as possible, communicating community social and health needs to decision-makers.

It is important to emphasize that *all* the cases report that they *understood* childhood immunization coverage in spatial terms; they all spoke of coverage rates being appreciably different in geographic terms, around the city, be it in terms of neighbourhoods, catchment areas, or in more general cardinal descriptions of their city (Northwest, West, etc.). Saskatoon and Regina were, however, the most specific in their geographic descriptions by using neighbourhood terminology to describe targeted interventions.

7.3.2.2.2 Visual Management

The specifics of *how* Saskatoon and Regina utilize spatial data are also similar. Both make efforts to prominently display geographic coverage data in their central regional offices ("Wall Walks" reported in Saskatoon; "Visibility Walls" reported in Regina). Parry and Turner (2006) describe visual aids used in this fashion as "activators" that enable management to motivate their workforce towards organizational behaviour change - this all occurring under the umbrella of a "visual management" philosophy. In a health care context, visual management is most closely associated with the aforementioned Lean management literature originating from vehicle manufacturing. As Lean emphasizes individuals' roles in providing value to patients, the visual management tool allows everyone to track performance, observe the prior record of that performance, and have access to documentation for evaluation on a day-to-day basis (Young, Hill, & Point, 2014).

It is therefore clear that the implementation of Lean in the province of Saskatchewan influenced this type of organizational behaviour, and indeed both the Saskatoon Health Region (2018) and Regina Qu'Appelle Health (2015) region provide educational materials on visual process management on their websites. Though there is a growing literature on the utility of using spatial epidemiology in public health, many articles continue to conclude their discussions with the supposition that spatial data *is likely* to improve knowledge translation efforts into the policy-making sphere. The Saskatoon and Regina cases represent the next steps of this body of research by showing that *integrating geographic data* to the visual management process may be essential to actually moving a policy-agenda forward and improving public health practice. Presently, there is no research exploring the impact of using of spatial epidemiological data as a management tool in public health.

7.3.2.3 Diagnose

The following discussion is framed around the "Diagnose" domain of the WHO TIP policy process, reporting how the public health programs in this study detected the demand- and supply-side barriers to comprehensive childhood immunization coverage within their jurisdictions:

7.3.2.3.1 Front-line and patients' wisdom to assess accessibility

All the cases emphasized nurse input into policy-making as vital in their diagnosis step. Along with providing the immunizations themselves, the nurses' front-line wisdom as to why some patients in certain geographical regions do not fully immunize (diagnosing) informed the solutions that management developed. Nurse input was made possible in all the cases by organizational policy-related communication flowed both top-down and bottom-up within their hierarchies, mostly organized in the following orientation: Central management > Clinic-specific management > Supervisors > Nurse.

Indeed, many nursing organizations in Canada advocate for nurses being central in policy-making within their organizations (College of Registered Nurses of British Columbia, 2012; Manitoba Health, 1998; RPNAO, 2018; SRNA, 2013). In 2015, a qualitative study from the UK demonstrates that public health nurses are deeply familiar with health equity and the need for targeted interventions that take the social determinants of health into account (Mabhala, 2015). Many commentaries do, at the same time, report that nurses are generally underutilized in policy decision-making due factors such as a lack of policy-related awareness and training among nurses, and time constraints (Brokaw, 2018; Duquesne University School of Nursing, 2018; Kunaviktikul, 2012; Nelson, 2016). Recommendation from these commentaries centre around obtaining more diverse training and networking with nursing associations and other policy-makers to influence changes (Oestberg, 2013). The reporting from the four study cases in this study corroborates that nurses do provide uniquely valuable public health intelligence for the policy-making process and may be able to be further leveraged into decision-making.

Most cases also reported that they assessed barriers to access immunization services by engaging patients, be it through focus groups (Edmonton and Saskatoon), patient satisfaction survey data (Calgary), or through the reports from community-based workers who directly engage with patients, outside the clinics (Saskatoon). These engagements directly defined the solution spaces in which policy interventions were conceptualized, with *improving accessibility* being the main programmatic and policy goal.

Levesque at al. (2013) describe accessibility to health care as the alignment of several health care system dimensions with patient skills: Approachability, Acceptability, Availability and accommodation, Affordability, and Appropriateness dimensions on behalf of the system; and Ability to pay, Ability to seek, Ability to reach, and Ability to engage on behalf of patients, respectively (Figure 7-8). This framework can provide an explanatory link between barriers patients face in health care in general and the social determinants of health stratifiers used in this study. The analysis showed that geography, income and to a lesser extent, %-homeownership, significantly influenced inequities in coverage rates among the cases. These social determinants particularly align with "Availability and accommodation / Ability to reach" and "Affordability / Ability to pay" dimensions of the framework.

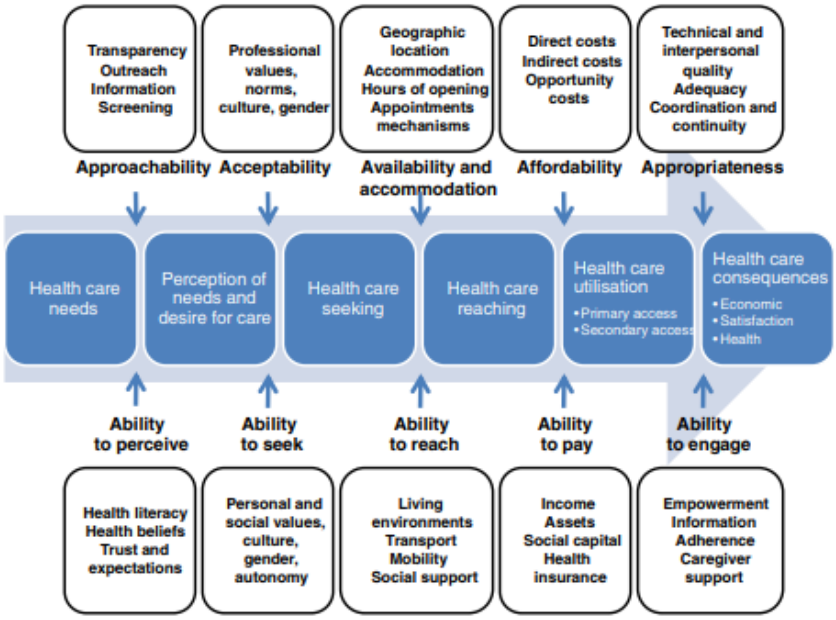


Figure 7-8: A Conceptual framework of access to health care reprinted from Levesque, J. F., Harris, M. F., & Russell, G. (2013). Patient-centred access to health care: Conceptualising access at the interface of health systems and populations. International Journal for Equity in Health, 12(1), 1–9. https://doi.org/10.1186/1475-9276-12-18. Creative Commons 2.0.

The combination of the fact that public health services are delivered out of particular facilities, and that patients in general do not all have the same levels of mobility and transportation capabilities, suggest geographic inequities are inevitable when services are not geographically targeted. Geographical considerations align with the "Availability and accommodation" and "Ability to reach" cross-section of

the Levesque framework. “Geographic location, “Accommodation”, “Hours of opening” and “Appointment mechanisms” are all supply-side functions of public health services management policies and can be used as *system* targets of intervention. Considerations about living environments, transportation, mobility and social supports are all in their own way associated with distinct geographies and represent *patient-oriented* targets for intervention to alleviate geographic inequities.

Of all the socio-economic stratifiers (all stratifiers excluding just geography), the income stratifiers elicited the largest inequities among all cases, suggesting that those with less income, assets and/or social capital, according to Levesque’s framework, hinders parents’ ability to pay the *indirect costs and/or opportunity costs* associated with their child’s first MMR immunization appointment. These costs may include those associated with transportation to clinics, time off of work to attend clinics, or the social connections to arrange for childcare in multi-children households. The income barrier also influences the “availability and accommodation” dimension as income deficiencies can also influence access to transportation and social support.

The “Appointment mechanisms” consideration in the “Availability and Accommodation” dimension also provides insight into why %-home-ownership appeared as a significant factor in some cases. It is likely that those who are more transient would be more difficult to reach with the reported mail-out letter and phone modes of reminders. The fact that %-home-ownership was so starkly a factor in Regina suggests that there is something unique about the effect of home-ownership on parents in Regina neighbourhoods that would be worth further investigating. Figure 7-9 summarizes all the considerations to accessibility that can be made for childhood immunization coverage inequities across three of Levesque’s dimensions that apply to the study findings:

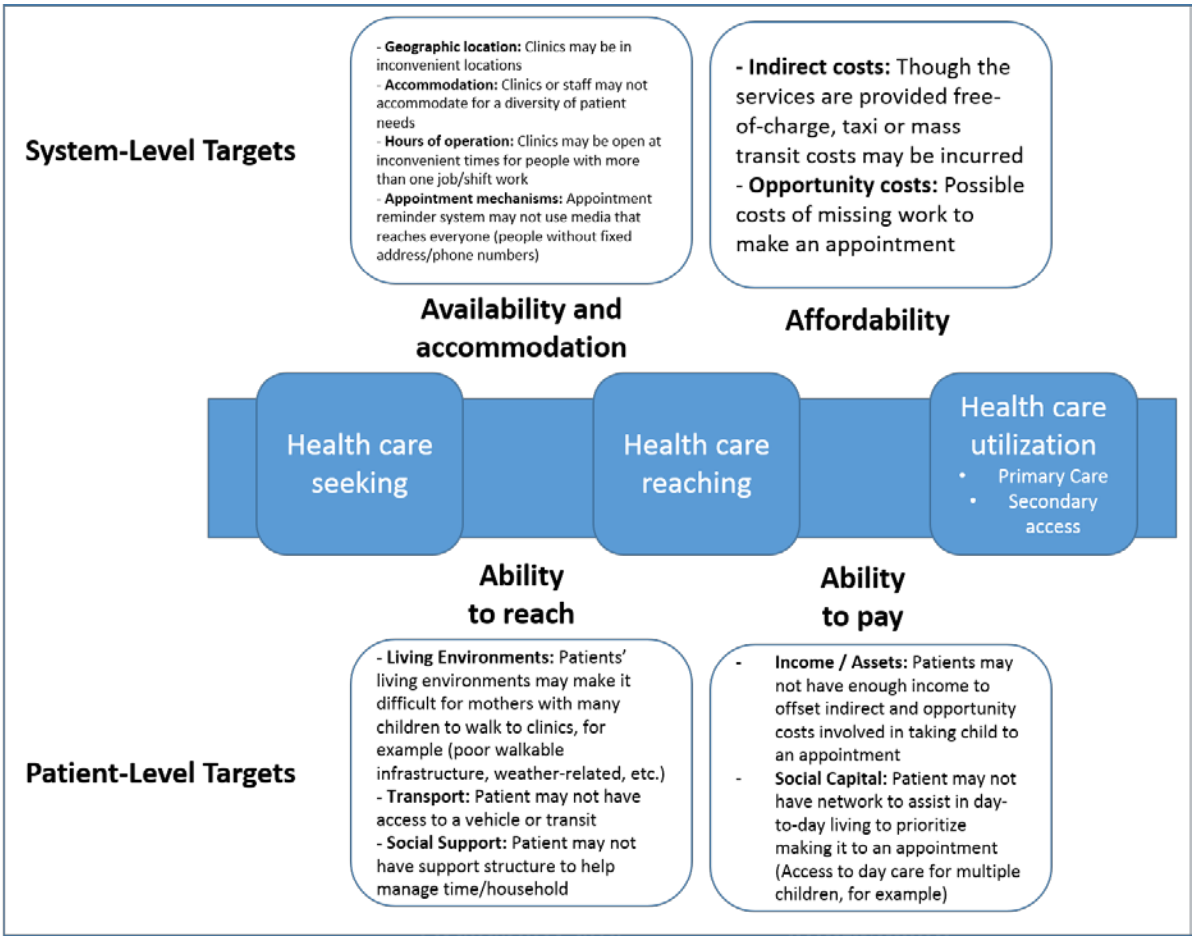


Figure 7-9: Application of the study findings into an adaptation of Levesque et al.'s (2013) conceptual framework of access to healthcare focusing on the "health care seeking", "health care reaching" and "health care utilization" domains

7.3.2.4 Design

The following discussion is framed around the "Design" domain of the WHO TIP policy process, reporting lessons learned from the cases regarding equity-based childhood immunization interventions themselves, their implementation and how they are evaluated:

7.3.2.4.1 Reminder systems

The use of reminder systems to contact those who are behind in immunizations were ubiquitous across the cases, where immunization records are electronically retrieved, and parents are either contacted by nurses & clerks (Edmonton), and/or through the use of an autodialer messaging system (Calgary, Saskatoon, Regina), mailed letters (all cases), and home visits (Saskatoon). Saskatoon's system underwent the most

extensive changes by first deploying a geographically-targeted pilot utilizing multiple reminder media, leveraging unique human resources (Community program builders; home visits) to reach parents to intensify the reminders system, and to then using the most successful combined reminder strategies across the whole city in a targeted-universalist manner.

The most recent Cochrane review on the topic of reminder systems in immunization programming used the evidence of 75 studies across 10 countries to conclude with high certainty that the use of postcards, text messages and autodialers, and with moderate certainty that the use of telephone calls and letters, improve the receipt of immunization overall; and with high certainty that reminders in general improve rates in children. They also mention that combining reminder media were also effective, such as the combination of mail and telephone, or of any reminder with outreach (Jacobson Vann, Szilagyi, Jacobson, Coyne-Beasley, & Asafu-Adjei, 2018). This last finding suggests that there may be a dosage effect (effect is proportional to the number of interventions) to reminder strategies that worked especially well in Saskatoon, as they deployed the most varied combinations of media to remind parents about missed immunizations, but in a needs-based equity-related manner which specified which reminder systems were to be used with a given population.

7.3.2.4.2 Supply-side interventions; inequality paradox

All cases mentioned that they increased supply-side immunization service, namely by extending clinic hours and clinic availability to parents as a means to increase immunization rates. Because it was equally reported, it is difficult to assess the effectiveness of this practice in this study. It was a supply-side intervention (the mass immunization clinics), however, that was uniquely intensely implemented in Calgary during the 2013 outbreak, providing a case example of how a particularly *untargeted* intervention may preferentially reach some populations over others.

Frohlich and Potvin (2008) argue that universal population-approach interventions have the potential to exacerbate health disparities in a phenomenon known in public health as the “Inequality Paradox”. One emblematic example they provide is in their reference to Federico et al.’s 2007 study on a population-

based health information campaign to reduce smoking. Their analysis showed that gaps in the subsequent smoking initiation rates between educational groups may have been the result of the educational campaign being more effective among those with a higher level of education. Over time, this would ostensibly result in the continued reduction of smoking rates in high-education groups, and a slower-or-null reduction in low-education groups. This inequality paradox appears to have taken place in Calgary where interventions were most intensely deployed as a result of the outbreak in a universal, population-based manner: Specifically, while immunization rates across all quintiles increased due to interventions and awareness that took place over the outbreak, the coverage rates increased the highest in the higher income quintiles. As for reasons this may have occurred, the mass immunization clinics may have been placed in areas that were disproportionately accessible to people living in higher income neighbourhoods, or the reported "long-lines" (CBC News, 2014) at the clinics may have disproportionately allowed for those with more flexible time schedules to be served more often. If a targeted-universal approach to outbreak mitigation during the measles outbreak that considered differing levels of accessibility across neighbourhood income quintiles were to have been deployed, there may have been a more equitable increase in coverage rates across Calgary.

7.3.2.4.3 Quality improvement and a learning system

While all cases reported using a multitude of data such as wait time, errors, and patient satisfaction in their regular reporting structure, Saskatoon and Regina utilized intensive geographical, equity-based visual management systems to ensure that any interventions deployed by these programs are subject to a rapid equity-based evaluation, conducted in an 'iterative' fashion. This policy design process most resembles the Plan, Do, Study, Act cycle (PDSA) (Berwick, 1989) a well-established rapid quality improvement (QI) methodology utilized across health care fields including gastroenterology, neonatal care, and pediatric surgery (Morelli, 2016; Nakayama et al., 2010; Stikes & Barbier, 2013), where organizations define objectives, carry out a planned intervention, study the effects and act on the findings to iterate in quick successions on specific problems. While QI methodologies are increasingly utilized in public health, a 2012 systematic review (2012) concludes that most published QI research projects in

public health did not utilize outcome data in their analysis, rather more focus on building QI capacity within institutions. In one study that has used outcome data since, Livingood (2013) demonstrates the purposeful implementation of the PDSA cycle in public health, including the use of data visualization tools similar to the “wall walk”/“visibility walls”, improved both up-to-date immunization rates among two year old children and specific indicators of a “QI culture” within a Floridian public health department.

As iteration is key to equity-based programming, the PDSA QI methodology is especially appropriate for improving health equity, as it is described as being flexible to “accept that not all change will work as planned and that it is crucial to create a *learning culture*” (Moule, Evans, & Pollard, 2013, p.594). Herein lies the opportunity to make public health systems “smarter” - to learn more quickly through the use of health equity data to better target programming at a responsive rate. The need for “smarter” systems in healthcare has recently culminated in the notion of a “rapid-learning health system” defined as a system in which “science, informatics, incentives, and culture are aligned for continuous improvement and innovation, with best practices seamlessly embedded in the delivery processes and new knowledge captures as an integral by-product of the delivery experience” (Cortese, Brennan, & Odom, n.d., p.17). Here again visual management appears as an element of a learning system, where a *continuous, data-driven visual accountability* structure drives improvement. The rapid-learning system terminology is rarely associated with public health and even-less from an equity perspective but may be most appropriate way of describing the process required to iteratively conduct effective equity-related programming.

Chapter 8 : Limitations

8.1 Immunization data

As cited earlier, immunization data in Canadian information systems and practices widely vary across the country. The main limitations of the one-dose MMR data between the case provinces was that the data did

not consider immigration or emigration of children between postal codes; the children in the numerators and denominators for any given year were assigned to the postal codes *they lived in at the time of pulling the data (2016)*. The data is therefore retrospective, but a-historical in that it does not capture the cross-sectional location of two-year old children in each year. Alberta did not save copies of their yearly snapshots of data, while the Saskatchewan cases did. This forced the Saskatchewan analysts to also pull the data a-historically. This limitation, however, is minimal because overall, families do not tend to drastically change their economic position over short-term timeframes and thusly, not likely to move across quintiles. In their longitudinal study using income data between the years 1982 to 2012, Statistics Canada (Zhang, Saani & Chung 2016) reports that the five-year change in family annual income between the 2007 to 2012 timeframe was actually the closest to zero percent it had been in 15 years. Their 10-year period analysis showed that between 2001 and 2001, and 2002 and 2012, families averaged an increase in annual income of around 8%. Even at this rate, and even if any of 2-year old children and their families in this study were to have moved to a slightly higher-income neighbourhood due to this increase during the study period, it is unlikely that they would have moved *across quintiles* of neighbourhood – i.e. across the 20% contingent category of the entire population they represent.

8.2 Demographics

It is assumed in this study that the 2011 NHS-based neighbourhood data represents the demographics 2009 and 2015; that the demographics did not change within this period. The use of a "midpoint" analysis is not uncommon in studies over a period. It should also be noted that there is concern that the 2011 NHS provides poor estimates for most indicators as it was a voluntary survey.

The early reaction to the voluntary 2011 NHS was highly negative, culminating in a call for its withdrawal entirely in a Globe and Mail commentary article (Hulchanski, Murdie, & Bourne, 2018). It is specifically criticized for the possible high level of sampling error because only 68.6 % percent of Canadians completed the survey, compared to 93.8% in 2006. There are also concerns of non-response bias, in which, in this specific case, the fact that the survey may disproportionately under-represent those

whom are less likely to fill out the survey (low income citizens, for example). Statistics Canada's "The 2011 National Household Survey - the complete story" published in 2015 outlines that pre and post-hoc analyses they conducted using other data sources reveal that the primary limitation of the survey is its validity at the small geography level, where many communities' data were suppressed in areas with global non-response rates greater than 50% (W. R. Smith, 2015).

The fact that data was *not suppressed* at the neighbourhood level indicates that there are no neighbourhoods in the analysis with extremely high non-response rates (data collected by the cities from Statistics Canada). In the present study, sampling and non-response bias is attempted to be accounted for by:

1.) Aggregating geographies into quintiles and;

2.) By not comparing absolute demographic numbers (%-immigrant, %-aboriginal, %-homeownership, $ of income), between cities, or over time. Other analyses are necessary to assess whether absolute demographic inequalities are significant across the cities.

8.3 Qualitative information asymmetry

The cases had different amounts of publicly-available policy-related information to inform the study. The Saskatoon Health Region, for example, had very detailed (in some places, monthly) MMR policy and programming data on their website, while local policy-based data was almost non-existent in Alberta. Regina was in the middle of these cases in terms of publicly-available informational resources. It is also an observation of the author that that the degree of public documentation of childhood immunization coverage initiatives is proportional to the observed institutional knowledge around the topic among the interview participants, and also proportionate to the severity of under-immunization and inequities the city exhibited; the bigger the problem, the more information there was online and from participants, about the topic. The amplified equity-based efforts of Saskatoon and Regina during a particularly active period of equity-based immunization initiatives may have been a symptom of their *need* to improve inequities. It

is possible that Edmonton and Calgary may also have equity-based policies but may not explicitly present them as they may be so integrated in to their practice that equity-based practices are deemed unremarkable for interviewees to mention. A deeper investigation into the Alberta cases may yield more long-term embedded targeted interventions and policies.

8.4 Geographic resolution of analysis

Neighbourhoods are not constructed equally between cities. Both the number of people per neighbourhood and the socio-demographic homogeneity or heterogeneity within the neighbourhoods vary between jurisdictions and can impact health inequality measurement. Consequently, one possibility to consider is that neighbourhood-level analysis may not be sufficiently high-resolution to detect inequities. To address this concern, a dissemination-area (DA) level analysis was conducted in Calgary and Edmonton (the two cases with the least persistent inequities), using the income stratifier, as this is likely the stratifier to reveal the most pervasive inequities.

The dissemination area is a standardized unit of measure developed by Statistics Canada designed in geographies of around 400-700 people per block (Statistics Canada, 2018). The six-digit coverage data postal codes were converted to dissemination areas using the Statistics Canada Postal Code Conversion File, Version 6A (Statistics Canada, 2014). Dissemination area-level 2011 NHS data was retrieved from Statistics Canada using the Data Liberation Initiative through the University of Saskatchewan Library. The DA-level coverage rates were then linked to DA-level 2011 NHS income data. The yearly data were then ranked by income, and quintiles were formed using DA-level population numbers to split the population into 20% increments.

The results below show very similar patterns of quintile-level coverage at a higher DA-level resolution compared to the neighbourhood-level analysis. This re-analysis indicates that neighbourhood-level coverage was sufficient for the study purposes and that it is with certainty that Alberta cases generally exhibit low levels of coverage inequities.

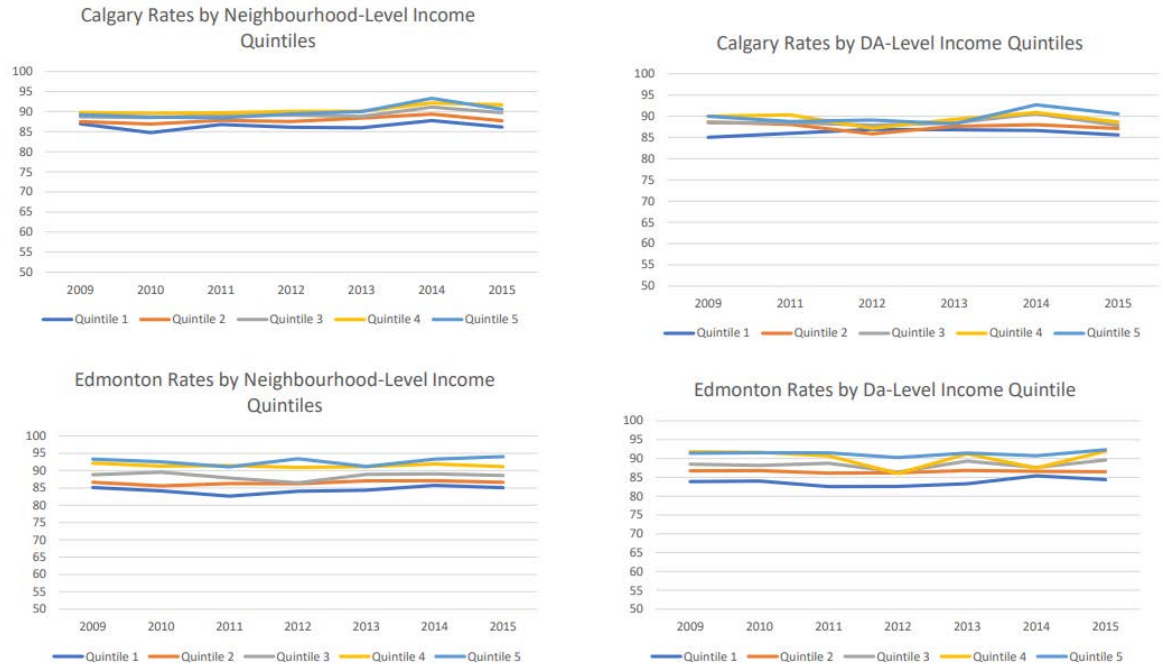


Figure 8-1: Comparison of neighbourhood and dissemination area-level MMR coverage rates stratified by income quintile for Calgary and Edmonton case studies between 2009 and 2015

8.5 Generalizability of cases

The cases in this study are unique and findings are not necessarily generalizable to other urban public health programs in Canada. Despite the efforts made to include all interested large public health units across the country into this study (which included all 13 Urban Public Health member cities), the number of cases were limited to four due to variable levels of access to valid immunization data among public health units. If immunization data was standardized across the country, there is no reason that the methodology employed in this study could not be applied to every large public health jurisdiction in Canada. With increasing number of cases, a larger study would be able to detect a more comprehensive picture of the state of public health practice vis-à-vis childhood immunization.

Chapter 9 : Conclusion: The Way Forward and agenda for future research

It is imperative that public health agencies act on health inequities. This study details this issue through the lens of childhood immunization coverage, where urban and provincial agencies in Saskatchewan and Alberta recognize that inequities are apparent and are within the mandate of public health to address. The analysis portrays actions through which organizations can identify, diagnose and design policies and programs by orienting their organizations towards utilizing equity-based intelligence and evidence-based practice.

The study also illuminated the effect of employing different types of programming - targeted, universal and targeted-universal. Targeted interventions, while reported as increasing the cost of practice, showed massive success in reducing inequities. The deployment of a universal intervention - the outbreak response in Calgary, specifically - showed how broad action can *increase* inequities. The targeted universal intervention approach, as exhibited by Saskatoon, shows how iteration works to make improvements sustained over time. Overall, it is encouraging to see that with sufficient dedication, an urban public health unit can reduce inequities.

Regarding population health intervention research (the "What") literature, this study contributes a rich account of four natural experiments; the public health events of 2009-2015 in four urban centres, the context in which these events occurred and the policy levers that were utilized by public health programs. The analysis demonstrated what worked in Saskatoon and Regina when equity-based public health outcomes were poor and improvements were pursued. In Alberta, while equity-based improvements were not being actively pursued, the outbreak event showed that equity can be impacted in already high-functioning systems.

The institution-level deconstruction of public health practice in the four cases contributes to the nascent public health systems of services research (the "How") literature in Canada. This exercise unearthed some

drivers of evidence-based public health practice, particularly the importance of the systematic use of geographic, front-line and patient-level data in public health practice improvement. It is important to note that this type of description, though lacking in the Canadian peer-reviewed literature, is growing in the grey-literature. More systematic investigations of system-level mechanisms would corroborate the non-peer reviewed accounts of public health currently available.

The use of a comparative case study methodology helped reveal that while each urban public health programs face unique challenges, at different times from each other, there are some basic commonalities that can be used for further comparative analyses. For example, collecting specific institutional data like # of FTE positions, or budget dollars, and combining them epidemiological and policy-based data, could further reveal how access to human and financial resources can affect equity-based practice. Correlating dollars-per-100,000 citizens data, for example, across the country with public health outcome data could provide a basis for national and regional public health planning and budgeting recommendations. Overall, an inventory of public health practice in Canada is greatly needed to continue to assess public health performance across the country.

Chapter 10 : Recommendations

The following recommendations for urban public health units are informed by the study results and the relevant literature.

1. Public health agencies should invest in local surveillance with an emphasis on geographic analysis and utilize a quality improvement and "learning system" ethos of iteration and data-informed policy-making when designing and implementing interventions
2. Evidence from surveillance, front-line professionals, patients and the literature can provide public health agencies intelligence on specific sub-geographic and demographic-related reasons inequities exist
3. Immunization data collection and definition protocols must be standardized across the country to comprehensively assess the immunization status of populations in Canada
4. Public health agencies should consider equity when designing large-scale immunization interventions to avoid *increasing* health inequities
5. Make reducing inequities in childhood immunization a provincial priority and build provincial networks to facilitate sharing of best practices to improve policy coordination across local jurisdictions

These recommendations represent actions public health units can take to reduce inequities in childhood immunization coverage and may be applicable to inequities for other health outcomes. These recommendations are, however, contingent on availability of capacity to conduct these human, knowledge and capital resource-intensive practices, which we know is not consistent across the country. Providing adequate funding to public health units is therefore also necessary.

It is also important to understand that public health cannot eliminate health inequities alone. Progress on improving the social determinants of health for all must be addressed in an intersectoral manner, mobilizing collaborative efforts among all levels of government, non-government, private and citizen organizations. Equity is a shared responsibility, and should above all, be the goal of a just modern society.

Chapter 11 : References

Abrametz, B., Bragg, T., & Kendel, D. (2016). *Optimizing and integrating optimizing and integrating patient-centred care: Saskatchewan advisory panel on health system structure report*. Retrieved from https://www.saskatchewan.ca/~/media/news release backgrounders/2017/jan/saskatchewan advisory panel on health system structure report.pdf?la=en

Academy Health. (2009). *Addressing Disparities Through Public Health Systems & Services Research and Adaptations to Public Health Practice*.

Alberta Health. (2007). Alberta immunization strategy 2007- 2017. Retrieved from www.health.alberta.ca/documents/Immunization-Strategy-07.pdf

Alberta Health Services. (2011). Alberta Health Services Annual Report 2010 - 2011.

Alberta Health Services. (2012). Alberta Health Services Annual Report 2011-2012.

Alberta Health Services. (2013). Alberta Health Services Annual Report 2012-2013.

Alberta Health Services. (2014a). Alberta Health Services: Annual Report 2013-2014, 1–184. Retrieved from http://www.albertahealthservices.ca/Publications/ahs-pub-2013-2014-annual-report.pdf

Alberta Health Services. (2014b). *Measles outbreak declared over in AHS Edmonton Zone*. Retrieved from https://www.albertahealthservices.ca/news/releases/2014/Page10168.aspx

Alberta Health Services. (2014c). Public Service Announcement Measles outbreak declared over in the Calgary and Central Zones of Alberta Health Services, 29–30. Retrieved from https://www.albertahealthservices.ca/psa/ne-psa-2014-06-12-measles.pdf

Alberta Health Services. (2015a). *Alberta Health Services Annual Report 2014-15*.

Alberta Health Services. (2015b). Alberta Health Services Annual Report 2014-15.

Alberta Health Services. (2015c). Alberta Health Services Annual Report 2015-16.

Alberta Health Services. (2018a). Capital projects Calgary zone. Retrieved July 14, 2018, from https://www.albertahealthservices.ca/about/calgaryzone.aspx

Alberta Health Services. (2018b). Emergency services and health centre locations. Retrieved June 20, 2018, from http://www.healthyparentshealthychildren.ca/local-resources-and-supports/edmonton-zone/emergency-services-and-health-centre-locations/

Alberta Health Services. (2018c). How healthy are we? Retrieved July 20, 2018, from https://www.albertahealthservices.ca/services/Page13516.aspx

Alberta Health Services. (2018d). Non-routine immunization services. Retrieved June 20, 2018, from https://www.albertahealthservices.ca/info/service.aspx?id=1066413

Alberta Health Services. (2018e). Vaccinations and community health centres. Retrieved July 15, 2018, from http://www.healthyparentshealthychildren.ca/calgary-zone/vaccinations-and-community-health-centres/

Alberta IHDA. (2018). Welcome to the IHDA Data. Retrieved August 28, 2018, from http://www.ahw.gov.ab.ca/IHDA_Retrieval/ihdaData.do

Asthana, S., & Halliday, J. (2006). Developing an Evidence Based for Policies and Interventions to Address Health Inequalities: The Analysis of “Public Health Regimes.” *The Milbank Quarterly*, *84*(3), 577–603.

Atchison, C., Zvoc, M., & Balakrishnan, R. (2013). The Evaluation of a Standardized Call / Recall System for Childhood Immunizations in Wandsworth, England. *Journal of Community Health*, 581–587. https://doi.org/10.1007/s10900-013-9654-4

Awofeso, N. (2004). What's New About the "New Public Health"?, *94*(5), 705–709.

Bascu, J. & McQueen Smith, M. 2011. *Innovations in Knowledge Translation: the SPHERU ST Casebook.* Saskatchewan Population Health and Evaluation Research Unit. Retrieved from: http://www.spheru.ca/publications/files/SPHERU%5CnKT%5CnCasebook%5CnJune%5Cn2011.pdf%5Cnhttp://www.spheru.ca/publications/files/SPHERU KT Casebook June 2011.pdf

Bekemeier, B. (2013). Using Geographic Information Systems to Investigate the Relationship between Local Health Department's Workforce Cuts and Vulnerable Populations. In *Keeneland Conference* (pp. 1–19).

Béland, D. Politics and policy in Brad Wall's Saskatchewan. *Policy Options.* Retrieved from: http://policyoptions.irpp.org/magazines/continuity-and-change-in-the-provinces/politics-and-policy-in-brad-walls-saskatchewan/

Béland, D., & Howlett, M. (2016). The role and impact of the multiple-streams approach in comparative policy analysis. *Journal of comparative policy analysis: Research and practice, 18:3,* 221-227.

Bell, M., & Macdougall, K. (2013). Adapting online learning for Canada's Northern public health workforce. *International Journal of Circumpolar Health*, *1*(c), 1–7.

Berwick, D. M. (1989). Continuous improvement as an ideal in health care. *The New England Journal of Medicine*, *320*, 53–56. https://doi.org/10.1056/NEJM198901053200110

Bonnefoy, J., Gilson, L., Hertzman, C., Kelly, M. P., Kjellstrom, T., Lundberg, O., & Vaghri, Z. (2010). Priorities for research on equity and health: Implications for global and national priority setting and the role of WHO to take the health equity research agenda forward, (November).

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology Using thematic analysis in psychology, *0887*(January), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brearley, L., Eggers, R., Steinglass, R., & Vandelaer, J. (2013). Applying an equity lens in the Decade of Vaccines. *Decade of Vaccines*, *31*, *Supple*(0), B103–B107. https://doi.org/http://dx.doi.org.cyber.usask.ca/10.1016/j.vaccine.2012.11.088

Brokaw, J. J. (2018). Nursing professions potential impacts in policy and politics. Retrieved July 20, 2018, from https://www.americannursetoday.com/blog/nursing-professions-potential-impact-policy-politics/

Brown, L. D. (2010). The political face of public health. *Public Health Reviews*, *32*(1), 155–173. https://doi.org/10.1007/BF03391596

Brownson, R. C., Allen, P., Duggan, K., Katherine, A., & Erwin, P. C. (2012). Fostering More-Effective Public Health by Identifying Administrative Evidence-Based Practices: A review of the Literature. *American Journal of Preventive Medicine*, *43*(3), 309–319. https://doi.org/10.1016/j.amepre.2012.06.006.Fostering

Brownson, R. C., Chriqui, J. F., & Stamatakis, K. A. (2009). Understanding evidence-based public health policy. *American Journal of Public Health*, *99*(9), 1576–1583. https://doi.org/10.2105/AJPH.2008.156224

Buajitti, E., Watson, T., Kornas, K., Bornbaum, C., Henry, D., & Rosella, L. C. (2018). *Ontario atlas of*

adult mortality, 1992-2015: Trends in Local Health Integration Networks. Ontario Atlas of Adult Mortality. https://doi.org/10.13140/RG.2.2.21994.21440

Busby, C., Jacobs, A., & Muthukumaran, R. (2017). *In Need of Boost: How to Improve Childhood Vaccination Coverage in Canada*. Retrieved from https://www.cdhowe.org/sites/default/files/attachments/research_papers/mixed/Commentary_477.pdf%0Ahttps://www.cdhowe.org/sites/default/files/attachments/research_papers/mixed/Commentary_477_0.pdf

Butler, R., Macdonald, N. E., & Group, W. (2015). Diagnosing the determinants of vaccine hesitancy in specific subgroups : The Guide to Tailoring Immunization Programmes (TIP). *Vaccine*, *33*, 4176–4179. https://doi.org/10.1016/j.vaccine.2015.04.038

Canada Post. (2014). *Official abbreviations and symbols/ Listing of forward sortation area (FSA) codes in alphanumeric sequence*. Retrieved from https://www.canadapost.ca/cpo/mc/assets/pdf/business/nps/machineable_presort_fsalist_february2014.pdf

Canadian Council on Social Determinants of Health. (2014). *Maps to Inform Intersectoral Planning and Action*.

Canadian Institute for Health Information. (2015). *Trends in Income-Related Health Inequalities in Canada*.

Canadian Institute for Health Information. (2016). Public Health Expenditure in the NHEX Database, (December).

Canadian Institute for Health Information. (2017). *National Health Expenditure Trends, 1975 to 2017*.

Canadian Institute for Health Information. (2018). *Geospatial Analysis of Population Health Data Using Two Types of Mapping Software*.

CanImmunize. (2018). Why was CANImmunize created? Retrieved August 1, 2018, from https://www.canimmunize.ca/en/about

Carey, G., & Crammond, B. (2015). Social Science & Medicine Action on the social determinants of health : Views from inside the policy process. *Social Science & Medicine*, *128*, 134–141. https://doi.org/10.1016/j.socscimed.2015.01.024

Carey, G., Crammond, B., & Leeuw, E. De. (2015). Towards health equity : a framework for the application of proportionate universalism. *International Journal for Equity in Health*, 1–8. https://doi.org/10.1186/s12939-015-0207-6

CBC News. (2008, April 23). Station 20 West not dead yet, organizers say. *CBC News.* Retrieved from: https://www.cbc.ca/news/canada/saskatchewan/station-20-west-not-dead-yet-organizers-say-1.707087

CBC News. (2014a, April 30). Long lineup at Calgary measles immunization clinics. *CBC News*. Retrieved from http://www.cbc.ca/news/canada/calgary/long-lineup-at-calgary-measles-immunization-clinics-1.2627130

CBC News. (2014b, April 30). Measles outbreak triggers wave of baby immunizations. *CBC News*. Retrieved from https://www.cbc.ca/news/canada/edmonton/measles-outbreak-triggers-wave-of-baby-immunizations-1.2627720

CBC News. (2018, May 6). Calgary parents waiting for vaccination appointments. *CBC News*. Retrieved

from https://www.cbc.ca/news/canada/calgary/calgary-parents-waiting-for-vaccination-appointments-1.2632400

CDC. (2014a). Strategies for Reducing Health Disparities — Selected CDC-Sponsored Interventions, United States, 2014, *63*(1).

CDC. (2014b). U.S. Immunization Program: Successful reduction in racial and ethnic disparities in vaccination coverage among young children, *25*(9), 1682–1690. https://doi.org/10.1007/s13398-014-0173-7.2

Centers for Disease Control and Prevention. (2018). Measles, mumps and rubella (MMR) vaccination: What everyone should know. Retrieved May 20, 2018, from https://www.cdc.gov/vaccines/vpd/mmr/public/index.html

Centres for Disease Control and Prevention. (2016). Vaccines for Children Program (VFC) Information for Healthcare Providers from CDC, 204495.

CFIR Research Team-Center for Clinical Management Research. (2019) Tools and Templates: Codebook Template. Retrieved from https://cfirguidetemp.blog/wp-content/uploads/2017/04/cfircodebooktemplate10-27-2014.docx

Chadwick, E. (1842). *Report on the Sanitary Conditions of the Labouring Population of Great Britain.* Retrieved from: https://navigator.health.org.uk/content/edwin-chadwicks-report-sanitary-conditions-labouring-population-great-britain-was-published

CIHR. (2016). Population Health Intervention Research Initiative for Canada. Retrieved from: http://www.cihr-irsc.gc.ca/e/38731.html

Cockman, P., Dawson, L., Mathur, R., & Hull, S. (2011). Improving MMR vaccination rates : herd immunity is a. *British Medical Journal*, (1370), 1–6. https://doi.org/10.1136/bmj.d5703

College of Registered Nurses of British Columbia. (2012). Professional standards for registered nurses and nurse practitioners. *College of Registered Nurses of British Columbia*, 1–23. https://doi.org/10.1002/9781119199861.ch12

Community Prevention Services Task Force. (2010). *Increasing Appropriate Vaccination : Health Care System - Based Interventions Implemented in Combination (2010 Archived Review)*.

Cookson, R., Mirelman, A. J., Grif, S., Asaria, M., Dawkins, B., Norheim, O. F., Verguet, S., Culyer, A.J. (2017). Using Cost-Effectiveness Analysis to Address Health Equity Concerns, *Value Health, 20*, 206–212. https://doi.org/10.1016/j.jval.2016.11.027

Cortese, D. A., Brennan, D. R., & Odom, C. H. (2011). *The learning health system and its innovation collaboratives: Update Report*. Retrieved from http://www.nationalacademies.org/hmd/~/media/Files/Activity Files/Quality/VSRT/Core Documents/ForEDistrib.pdf

Crocker-Buque, T., Edelstein, M., & Mounier-jack, S. (2016). Interventions to reduce inequalities in vaccine uptake in children and adolescents aged < 19 years : a systematic review. *British Medical Journal*, 1–11. https://doi.org/10.1136/jech-2016-207572

CSDH. (2008). *Closing the gap in a generation: health equity through action on the social determinants of health. Final Report of the Commission on Social Determinants of Health.* Geneva.

Cushon, J., Neudorf, C, Kershaw, T., Dunlop, T., Muhajarine, N. 2012. Coverage for the entire population: Tackling immunization rates and disparities in Saskatoon Health Region. *Canadian*

Journal of Public Health, 103(Suppl.2): 537-541.

Damschroder, L.J., Aron, D.C., Keith, R.E., Kirsh, S.R., Alexander, J.A., Lowery, J.C. (2009). Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. Implementation Science, 4: 50. doi: 10.1186/1748-5908-4-50.

de Leeuw, E., Clavier, C., & Breton, E. (2014). Health policy – why research it and how: health political science. *Health Research Policy and Systems*, *12*(1), 55. https://doi.org/10.1186/1478-4505-12-55

Department of Health New Brunswick. (2016). *Health Inequities in New Brunswick.*

Diener, T., Abbas, Z., & Granger, M. (2008). Immunization coverage rates among 2 year olds in the Regina Qu'Appelle Health Region, 2007. In *CPHR SPHERU Conference 2008*.

Dilley, J. A., Bekemeier, B., & Harris, J. R. (2012). Quality improvement interventions in public health systems: A systematic review. *American Journal of Preventive Medicine*, *42*(5 SUPPL. 1), S58–S71. https://doi.org/10.1016/j.amepre.2012.01.022

Dinour, L. M., Kwan, A., & Freudenberg, N. (2017). Use of Comparative Case Study Methodology for US Public Health Policy Analysis. *Journal of Public Health Management and Practice*, *23*(1), 81–89. https://doi.org/10.1097/PHH.0000000000000406

Dummer, T. J. B. (2008). Health geography: Supporting public health policy and planning. *Canadian Medical Association Journal*, *178*(9), 1177–1180.

Duquesne University School of Nursing. (2018). How nurse managers play a role in policy decision-making. Retrieved August 20, 2018, from https://onlinenursing.duq.edu/blog/nurse-managers-play-role-policy-decision-making/

Easton, G. (2010). Critical realism in case study research. *Industrial Marketing Management*, *39*(1), 118–128. https://doi.org/10.1016/j.indmarman.2008.06.004

Embrett, M. G., & Randall, G. E. (2014). Social determinants of health and health equity policy research: exploring the use, misuse, and nonuse of policy analysis theory. *Social Science & Medicine (1982)*, *108*, 147–155. https://doi.org/10.1016/j.socscimed.2014.03.004

Exworthy, M. (2008). Policy to tackle the social determinants of health: Using conceptual models to understand the policy process. *Health Policy and Planning*, *23*(5), 318–327. https://doi.org/10.1093/heapol/czn022

Exworthy, M., Berney, L., & Powell, M. (2002). 'How great expectations in Westminster may be dashed locally': the local implementation of national policy on health inequalities. *The Policy Press*, *30*(1), 79–96.

Fafard, P. (2015). Beyond the usual suspects: Using political science to enhance public health policy making. *Journal of Epidemiology and Community Health*, *69*(11), 1129–1132. https://doi.org/10.1136/jech-2014-204608

Fairchild, A. L., Rosner, D., Colgrove, J., Bayer, R., & Fried, L. P. (2010). The EXODUS of public health. What history can tell us about the future. *American Journal of Public Health*, *100*(1), 54–63. https://doi.org/10.2105/AJPH.2009.163956

Farrer, L., & Marinetti, C. (2015). *Advocacy for Healthy Equity: Case studies synthesis report*.

Fee, E., & Brown, T. M. (2005). Public Health Classics. *Bulletin of the World Health Organization*, *83*(04), 866–867. https://doi.org//S0042-96862005001100017

Fine, P. E. M. (1993). Herd Immunity : History, Theory, Practice. *Epidemiological Reviews*, *15*(2).

Fine, P., Eames, K., & Heymann, D. L. (2011). ‘“Herd Immunity”’: A Rough Guide, *52*, 911–916. https://doi.org/10.1093/cid/cir007

France, M., Vanbiervliet, F., & Simonnot, N. (2014). Immunisation coverage across Europe for groups facing multiple vulnerability factors, (April), 1–53.

Frederico, B.; Costa, G.; Kunst, A. E. (2007). Educational inequalities in initiation, cessation, and prevalence of smoking among 3 Italian birth cohorts. *American Journal of Public Health*, *97*(5).

Friel, S. (2009). Health equity in Australia : A policy framework based on action on the social determinants of obesity, alcohol and tobacco, (May).

Frohlich, K. L., & Potvin, L. (2008). Transcending the known in public health practice: The inequality paradox: The population approach and vulnerable populations. *American Journal of Public Health*, *98*(2), 216–221. https://doi.org/10.2105/AJPH.2007.114777

Fu, L. Y., Weissman, M., McLaren, R., Thomas, C., Campbell, J., Mbafor, J., Doshi, U. Cora-Bramble, D. (2012). Improving the Quality of Immunization Delivery to an At-Risk Population : A Comprehensive Approach. *Pediatrics*, *129*(2). https://doi.org/10.1542/peds.2010-3610

Gagnon, F., Bergeron, P., Clavier, C., Fafard, P., Martin, E., & Blouin, C. (2017). Perspective Why and How Political Science Can Contribute to Public Health ? Proposals for Collaborative Research Avenues. *International Journal of Health Policy and Management*, *6*(9), 495–499. https://doi.org/10.15171/ijhpm.2017.38

Geddes, L. (2014, April 30). Alberta declares measles outbreak. *Global News*. Retrieved from https://globalnews.ca/news/1299433/alberta-declares-measles-outbreak/

Gerein, K. (2015, May 1). Alberta sees rise in measles vaccinations after years of decline. *Edmonton Journal*. Retrieved from https://edmontonjournal.com/news/local-news/alberta-sees-rise-in-measles-vaccinations-after-years-of-decline

Gibson, J. M., Defelice, N., Sebastian, D., & Leker, H. (2014). Racial Disparities in Access to Community Water Supply Service in Wake County , North Carolina Racial Disparities in Access to Community Water Supply Service in Wake. *Frontiers in Public Health Services and Systems Research*, *3*(3). https://doi.org/10.13023/FPHSSR.0303.06

Gilbert, N. L., Gilmour, H., Wilson, S. E., & Cantin, L. (2017). Determinants of non-vaccination and incomplete vaccination in Canadian toddlers. *Human Vaccines and Immunotherapeutics*, *13*(6), 1447–1453. https://doi.org/10.1080/21645515.2016.1277847

Glatman-Freedman, A., & Nichols, K. (2012). The effect of social determinants on immunization programs. *Human Vaccines & Immunotherapeutics*, *8*(3), 293–301. https://doi.org/10.4161/hv.19003

Goodridge, D., Rana, M., Harrison, E. L., Rotter, T., Dobson, R., Groot, G., Udod, S., Lloyd, J. (2018). Assessing the implementation processes of a large-scale, multi-year quality improvement initiative: Survey of health care providers. *BMC Health Services Research*, *18*(1), 1–22. https://doi.org/10.1186/s12913-018-3045-6

Government of Canada. (2016). *Vaccine coverage in Canadian children: Highlights from the 2013 childhood National Immunization Coverage Survey (cNICS)*. Retrieved from https://www.canada.ca/en/public-health/services/publications/healthy-living/vaccine-coverage-canadian-children-highlights-2013-childhood-national-immunization-coverage-

survey.html?=undefined&wbdisable=true

Government of Canada. (2018). *Canada Health Act.* Retrieved from https://laws-lois.justice.gc.ca/eng/acts/c-6/page-1.html

Government of Canada. (2019). Canada's Provincial and Territorial Routine (and Catch-up) Vaccination Routine Schedule Programs for Infants and Children. Retrieved from: https://www.canada.ca/en/public-health/services/provincial-territorial-immunization-information/provincial-territorial-routine-vaccination-programs-infants-children.html

Government of Saskatchewan. (2016). *Saskatchewan Immunization Manual*.

Government of Saskatchewan. (2017). Understanding the health care system. Retrieved August 10, 2017, from https://www.saskatchewan.ca/residents/health/understanding-the-health-care-system

Gray, D. E. (2014). *Doing Research in the Real World*. Thousand Oaks, California: Sage Publications.

Harris, J. K., Beatty, K. E., Barbero, C., Howard, A. F., Cheskin, R. A., Shapiro, R. M., & Mays, G. P. (2012). Methods in public health services and systems research: A systematic review. *American Journal of Preventive Medicine*, *42*(5 SUPPL. 1), S42–S57. https://doi.org/10.1016/j.amepre.2012.01.028

Health Canada. (2003). *Learning from SARS: Renewal of Public Health in Canada.*

Hemenway, D. (2010). Why We Don't Spend Enough on Public Health, 1657–1658.

Herzog, C., Handke, C., & Hitters, E. (2018). Thematic Analysis of Policy Data. *The Palgrave Handbook of Methods for Media Policy Research*, (November), 1–17.

Hilliard, T., & Boulton, M. (2012). Public Health Workforce Research in Review: A 25-year Retrospective. *American Journal of Preventative Medicine*, *45*(5 Suppl 1), S17-28.

Hulchanski, D., Murdie, R., & Bourne, L. (2018, May). Canada's voluntary census is worthless. Here's why. *Globe and Mail*. Retrieved from https://www.theglobeandmail.com/opinion/canadas-voluntary-census-is-worthless-heres-why/article14674558/

Hunter, D. J., Popay, J., Tannahill, C., Whitehead, M., & Elson, T. (2009). *Learning Lessons from the Past : Shaping a Different Future.*

Hyde, J. (2009). Evaluation of Regionalization Planning Efforts in Kansas and Massachusetts.

IBM. (2009). *Panorama: Pan-Canadian Public Health Communicable Disease Surveillance & Management Project*.

Institute of Medicine. (1998). *The Future of Public Health*. The National Academies of Sciences, Engineering and Medicine.

Isaac, M. R., Chartier, M., Brownell, M., Chateau, D., Nickel, N. C., Martens, P., Katz, A., Sarkar, J., Hu , M., Burland, E., Goh, C., Taylor, C., PATHS Equity Team Members. (2015). Can opportunities be enhanced for vaccinating children in home visiting programs ? A population-based cohort study. *BMC Public Health*, 1–11. https://doi.org/10.1186/s12889-015-1926-8

Jacob, V., Chattopadhyay, S. K., Hopkins, D. P., Morgan, J. M., Pitan, A. A., & Clymer, J. M. (2016). Increasing Coverage of Appropriate Vaccinations. *American Journal of Preventive Medicine*, *50*(6), 797–808. https://doi.org/10.1016/j.amepre.2015.11.003

Jacobson, V. J. C., & Szilagyi, P. (2005). Patient reminder and patient recall systems to improve

immunization rates. *Cochrane Database of Systematic Reviews*, (3), CD003941. https://doi.org/10.1002/14651858.CD003941.pub2

Jobse, B.N., Adams, O., Levy, I. (2014). Population Health Management: A Canadian Perspective on the Future of Health Systems. *Canadian Journal of Physician Leadership, 4(1):8-15.*

Johnson, A G D; Kneebone, R. (2015). *A Geospatial Analysis: Low Childhood Immunization Rates in Alberta*. University of Calgary.

Johnston, J. C., McNeil, D., van der Lee, G., MacLeod, C., Uyanwune, Y., & Hill, K. (2017). Piloting CenteringParenting in Two Alberta Public Health Well-Child Clinics. *Public Health Nursing*, *34*(3), 229–237. https://doi.org/10.1111/phn.12287

Joint Task Group on Public Health Human Resources. (2005). *Building the Public Health Workforce for the 21 Century*.

Katz, S. L., King, K., Varughese, P., De Serres, G., Tipples, G., Waters, J., & Elimination, M. of the W. G. on M. (2004). Measles Elimination in Canada. *Journal of Infectious Diseases*, *189*(Supplement 1), S236–S242. https://doi.org/10.1086/378499

Kershaw, T., Suttorp, V., Simmonds, K., & T, S. J. (2015). Outbreak of measles in a non-immunizing population, Alberta 2013. *Canada Communicable Disease Report CCDR*, *40*(12), 1–7.

Kingdon, J. W., 1984, Agendas, Alternatives and Public Policies (Boston: Little, Brown and Company)

King, A. C., & King, D. K. (2010). Physical activity for an aging population. *Public Health Reviews*, *32*(2), 401–426.

King, A., Varughese, P., Serres, G. D., Tipples, G., & Waters, J. (2004). Measles Elimination in Canada. *The International Journal of Infectious Diseases.* (Suppl 1), 236–242.

Knight, E. K. (2014). Shifting Public Health Practice to Advance Health Equity : Recommendations from Experts and Community Leaders. *Journal of Public Health Management Practice*, *19716*, 188–196. https://doi.org/10.1097/PHH.0b013e31829959fb

Kominski, G. F., & Bastani, R. (2013). Are HPV Vaccination Services Accessible to High-Risk Communities? A Spatial Analysis of HPV-Associated Cancer and Chlamydia Rates and Safety-Net Clinics. *Cancer Causes Control*, *24*(12), 1–17. https://doi.org/10.1007/s10552-013-0286-x.Are

Kowal, S. P., Jardine, C. G., & Bubela, T. M. (2015). "If they tell me to get it, I'll get it. If they don't….": Immunization decision-making processes of immigrant mothers. *Canadian Journal of Public Health*, *106*(4), e230–e235. https://doi.org/10.17269/CJPH.106.4803

Krieger, N. (1994). Epidemiology and the web of causation: Has anyone seen the spider? *Social Science & Medicine*, *39*(7), 887–903. https://doi.org/10.1016/0277-9536(94)90202-X

Kulig, J. C., Meyer, C. J., Hill, S. A., Handley, C. E., Lichtenberger, S. M., & Mycks, S. L. (2002). Refusals and delay of immunization within Southwest Alberta. *Canadian Journal of Public Health*, *93*(2), 109–112.

Kunaviktikul, W. (2012). Nursing and Health Policy Perspectives. *International Nursing Review*, *59*(4), 438–438. https://doi.org/10.1111/j.1466-7657.2012.01044.x

Larkin, P. J. (1996). John Kingdon's "Three Streams" Theory and the Antiterrorism and Effective Death Penalty Act of 1996. *Journal of Law and Politics*, *28*(25), 25–50.

Lawson, M., Mierzwa, S., & Knapp, M. (2013). Characteristics Of A Local Health Department

Associated With The Use Of The Health Equity Index. *Frontiers in Public Health Services and Systems Research, 2*(6). Retrieved from http://uknowledge.uky.edu/frontiersinphssr/vol2/iss6/5

Leider, J. P., Resnick, B., Bishai, D., & Scutchfield, F. D. (2018). How Much Do We Spend ? Creating Historical Estimates of Public Health Expenditures in the United States at the Federal, State, and Local Levels. *Annu. Rev. Public Health*, *39*, 471–487.

Lemstra, M., & Neudorf, C. (2008). *Health disparity in Saskatoon: analysis to intervention*.

Lemstra, M., Neudorf, C., Opondo, J., Toya, J., Kurji, A., Kunst, A., & Tournier, C. (2007). Disparity in Childhood Immunizations. *Pediatric Child Health*, *12*(10), 847–852.

Leppo, K., Ollila, E., Pena, S., Wismar, M., & Cook, S. (2013). *Health in All Policies: Seizing opportunities, implementing policies*.

Levesque, J. F., Harris, M. F., & Russell, G. (2013). Patient-centred access to health care: Conceptualising access at the interface of health systems and populations. *International Journal for Equity in Health*, *12*(1), 1–9. https://doi.org/10.1186/1475-9276-12-18

Lewin, S., Glenton, C., Daniels, K., Be, V. W., Jensen, J., Johansen, M., Aja. G.N., Qwarenstein M., Scheel, I.B. (2010). Lay health workers in primary and community health care for maternal and child health and the management of infectious diseases (Review). *Cochrane Database of Systematic Reviews 2010*, (3). https://doi.org/10.1002/14651858.CD004015.pub3.www.cochranelibrary.com

Livingood, W. C., Sabbagh, R., Spitzfaden, S., Hicks, A., Wells, L., Puigdomenech, S., Kramer, D.F., Butterfield, R., Riley, W., Wood, D.L. (2013). A quality improvement evaluation case study: Impact on public health outcomes and agency culture. *American Journal of Preventive Medicine*, *44*(5), 445–452. https://doi.org/10.1016/j.amepre.2013.01.011

Luyten, J., Diseases, M. I., Vandevelde, A., Damme, P. Van, Beutels, P., & Infectious, M. (2011). Vaccination Policy and Ethical Challenges Posed by Herd Immunity, Suboptimal Uptake and Subgroup Targeting, *4*(3), 280–291. https://doi.org/10.1093/phe/phr032

MedCalc Software. 2018. MedCal. Retrieved from: https://www.medcalc.org/index.php

Mabhala, M. A. (2015). Public health nurse educators' conceptualisation of public health as a strategy to reduce health inequalities: A qualitative study. *International Journal for Equity in Health*, *14*(1), 1–11. https://doi.org/10.1186/s12939-015-0146-2

Macdonald, M., & Pauly, B. (2015). Improve Public Health Systems and Services in Canada Funders. In *Keeneland Conference*.

Macdonald, N. E., Bortolussi, R., & Society, C. P. (2011). A Harmonized Immunization Schedule for Canada: A Call to Action. *Paediatric Child Health*, *16*(1), 29–31.

Macdonald, P. (2016). Ensuring excellence in immunization services. *Human Vaccine & Immunotherapeutics*, *12*(1), 252–254.

Mackenbach, J. P. (2009). Politics is nothing but medicine at a larger scale: Reflections on public health's biggest idea. *Journal of Epidemiology and Community Health*, *63*(3), 181–184. https://doi.org/10.1136/jech.2008.077032

Manitoba Health. (1998). *The role of Public health nurse within the regional health authority*. Retrieved from https://www.gov.mb.ca/health/rha/docs/rolerha.pdf

Manitoba Health Seniors and Active Living. (2018). Population Report - June 1, 2017. Retrieved July 30, 2018, from https://www.gov.mb.ca/health/population/

Mannheimer, L. N., Lehto, J., & Östlin, P. (2007). Window of opportunity for intersectoral health policy in Sweden - Open, half-open or half-shut? *Health Promotion International*, *22*(4), 307–315. https://doi.org/10.1093/heapro/dam028

Maravi, M. E., Snyder, L. E., Mcewen, L. D., Deyoung, K., & Davidson, A. J. (2017). Using Spatial Analysis to Inform Community Immunization Strategies. *Biomedical Information Insights*, *9*, 1–13. https://doi.org/10.1177/1178222617700626

Masters, R., Anwar, E., Collins, B., Cookson, R., & Capewell, S. (2017). Return on investment of public health interventions : a systematic review, 827–834. https://doi.org/10.1136/jech-2016-208141

Mays, G. (2012). *National Longitudinal Survey of Public Health Systems : Comparative Report of 2012 Results*. *University of Kentucky*.

Mays, G. P., & Hogg, R. A. (2015). Economic Shocks and Public Health Protections in US Metropolitan Areas. *American Journal of Public Health*, *105*, 280–287. https://doi.org/10.2105/AJPH.2014.302456

Mays, G. P., Scutchfield, F. D., Bhandari, M. W., & Smith, S. A. (2008). Understanding the Organization of Public Health Delivery Systems: An Empirical Typology. *The Milbank Quarterly*, *86*(4), 529–532. https://doi.org/10.1111/j.1468-0009.2008.00538.x

McInnes, A. M., & Kennedy, L. (2009). *Innovation immunization fund: Evaluation of five urban outreach project - March 2007 - March 2009*.

McIntyre, P. B., & Menzies, R. I. (2005). Immunisation: reducing health inequality for Indigenous Australians. *The Medical Journal of Australia*, *182*(5), 207–208. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/15748128

Mckinlay, J. B. (1998). Paradigmatic obstacles to improving the health of populations -Implications for health policy *, *40*(4), 2–5.

Minister of health and long-term care expert panel on public health. (2017). *Public health within an integrated health system: Report of the minister's expert panel on public health*. Retrieved from http://www.health.gov.on.ca/en/common/ministry/publications/reports/public_health_panel_17/expert_panel_report.pdf

Ministry of Health and Long-Term Care. (2016). *Ontario Public Health Standards 2008*.

Morelli, M. S. (2016). Using the Plan, Do, Study, Act Model to Implement a Quality Improvement Program in Your Practice. *American Journal of Gastroenterology*, *111*(9), 1220–1222. https://doi.org/10.1038/ajg.2016.321

Moule, P., Evans, D., & Pollard, K. (2013). Using the Plan-Do-Study-Act model: Pacesetters experiences. *International Journal of Health Care Quality Assurance*, *26*(7), 593–600. https://doi.org/10.1108/IJHCQA-09-2011-0053

Mowat, D. L., & Butler-jones, D. (2007). Public Health in Canada : A Difficult History. *Health Papers*, *7*(3), 31–36.

Muscat, M. (2011). Who Gets Measles in Europe ? *The Journal of Infectious Diseases*, *1899*(Suppl 1), 353–365. https://doi.org/10.1093/infdis/jir067

Nakayama, D. K., Bushey, T. N., Hubbard, I., Cole, D., Brown, A., Grant, T. M., & Shaker, I. J. (2010). Using a Plan-Do-Study-Act cycle to introduce a new or service line. *AORN Journal*, *92*(3), 335–343. https://doi.org/10.1016/j.aorn.2010.01.018

National Collaborating Centre for Determinants of Health. (2011). Integrating social determinants of health and health equity into Canadian public health practice : Environmental scan 2010, (March), 1–90. Retrieved from http://nccdh.ca/images/uploads/Environ_Report_EN.pdf

National Collaborating Centre for Determinants of Health. (2018). Recent health equity developments in Manitoba. Retrieved August 21, 2018, from http://nccdh.ca/blog/entry/recent-health-equity-developments-in-manitoba

National Collaborating Centres for Public Health. (2017). About Us. Retrieved from http://nccph.ca/about-us/

National Institute for Health and Clinical Excellence, N. H. S. (2009). *Reducing differences in the uptake of immunisations (including targeted vaccines) among children and young people aged under 19 years*. London: National Institute for Health and Clinical Excellence.

Nelson, R. (2016). Are Nurses Being Nudged out of Policymaking? *American Journal of Nursing*, *116*(9), 14. https://doi.org/10.1097/01.NAJ.0000494675.15842.55

Nova Scotia Health Research Foundation. (2018). Mapping health geography. Retrieved June 18, 2018, from https://www.nshrf.ca/programs-services/programs/workshops/mapping-health-geography

Oestberg, F. (2013). Getting involved in policy and politics. *Nursing Critical Care*, *8*(3), 48.

Pampalon, R., Hamel, D., & Gamache, P. (2010). Health inequalities, deprivation, immigration and aboriginality in Canada: A geographic perspective. *Canadian Journal of Public Health*, *101*(6), 470–474. https://doi.org/10.2307/41995525

Parry, G. C., & Turner, C. E. (2006). Application of lean visual process management tools. *Production Planning and Control*, *17*(1), 77–86. https://doi.org/10.1080/09537280500414991

Penny, G. (2014). What do we know about Canada's Public Health Workforce? *CPHA Health Digest*, *XXXVII*(4).

Peterson-hickey, M., & Edelman, K. (2013). Addressing Health Inequities - The Role of Local Health Departments in Minnesota. In *Keeneland PHSSR Conference 2013*.

Petticrew, M., Cummins, S., Ferrell, C., Findlay, A., Higgins, C., Hoy, Kearns, A., Sparks, L. (2005). Natural experiments: An underused tool for public health? *Public Health*, *119*(9), 751–757. https://doi.org/10.1016/j.puhe.2004.11.008

Philippon, D. (2018). What do we expect to gain from health system reorganization? Retrieved August 9, 2018, from https://www.healthinnovationforum.org/article/what-do-we-expect-to-gain-from-health-system-reorganization/

Public Health Agency of Canada. (2008). *Core Competencies for Public Health in Canada*.

Public Health Agency of Canada. (2011). *Toward health equity: Canadian approaches to the health sector role*.

Public Health Agency of Canada. (2018). *Key Health Inequalities in Canada*.

Public Health Observatory Saskatoon Health Region. (2014). *Promoting Health Equity : An Evaluation of a Knowledge Translation Project Led by the Saskatoon Health Region's Public Health Observatory*.

Public Health Ontario. (2018). Maps. Retrieved August 20, 2018, from https://www.publichealthontario.ca/en/DataAndAnalytics/Maps/Pages/default.aspx

QSR International. (n.d.). NVIVO. https://doi.org/10.1109/TDEI.2009.5211872

Quinn, S. C., & Kumar, S. (2014). Health Inequalities and Infectious Disease Epidemics: A Challenge for Global Health Security. *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science*, *12*(5), 263–273. https://doi.org/10.1089/bsp.2014.0032

Raphael, D., Raphael, D., & Bryant, T. (2002). The limitations of population health as a model for a new public health. *Health Promotion International*, *17*(2), 189–199. https://doi.org/10.1093/heapro/17.2.189

Regina Qu'Appelle Health Region. (2010). *Regina Qu'Appelle Health Region Annual Report 2009/2010.*

Regina Qu'Appelle Health Region. (2012). *Regina Qu'Appelle Health Region: Health News Fall/Winter 2012*. Retrieved from http://www.rqhealth.ca/service-lines/master/files/healthnews_fall_winter2012.pdf

Regina Qu'Appelle Health Region. (2015). Better Everyday: Visual Management. Retrieved May 20, 2018, from http://www.rqhealth.ca/service-lines/master/files/visual_management_tool_kit.pdf

Regina Qu'Appelle Health Region. (2018a). Four directions community health centre: A brief history. Retrieved August 8, 2018, from http://www.rqhealth.ca/facilities-details/four-directions-community-health-centre-a-brief-history

Regina Qu'Appelle Health Region. (2018b). *Regina Qu'Appelle Health Region 2011/2012 Annual Report*. https://doi.org/10.1002/ejoc.201200111

Regina Qu'Appelle Health Region. (2018c). Visibility Walls. Retrieved August 6, 2018, from http://www.rqhealth.ca/department/quality-improvement-and-planning/visibility-walls

Region of Peel. (2011). *Health in Peel 2011*.

Rose, G. (2001). Sick individuals and sick populations. *International Journal of Epidemiology*, *30*(3), 427–432. https://doi.org/10.1093/ije/30.3.427

Rotter, T., Kinsman, L., Bath, B., Goodridge, D., Harrison, L., Dobson, R., Sari, N., Jeffery, C., Adegoyega, L, Kutz, M., Bourassa, C., Westhorp, G. (2014). A First Phase Evaluation of Saskatchewan's Lean Health Care Transformation: Final report, 1–55. Retrieved from http://research-groups.usask.ca/rotter/documents/select-publications/Lean Report - Full.pdf

RPNAO. (2018). Part Two: Leadership in Practice, Influencing Change. Retrieved August 20, 2018, from https://www.rpnao.org/practice-education/e-learning/nursing-policy-course

Rudolph, L; Caplan, J.; Ben-Moche, K.; Dillon, L. (2013). Health in All Policies: A Guide for State and Local Governments.

Rutty, C. (2010). *This is Public Health : A Canadian History*.

Saskatoon Health Region. (2011). *Towards Equity in Immunization: The Immunization Reminders Project*. Retrieved from https://www.saskatoonhealthregion.ca/locations_services/Services/Health-Observatory/Documents/Reports-Publications/TowardsEquityinImmunization_Final.pdf

Saskatoon Health Region. (2013). *Saskatoon Health Region Annual Report: 2012 - 2013*. https://doi.org/10.1002/ejoc.201200111

Saskatoon Health Region. (2014). *Achieving Equity in Immunization Coverage : Health Care Equity A Snapshot of Actions*.

Saskatoon Health Region. (2015). Interpretation and Translation Services. Retrieved from https://www.saskatoonhealthregion.ca/about/RWPolicies/7311-20-013-Appendix-A.pdf

Saskatoon Health Region. (2016). Immunization Initiatives 2015 Annual Report, (May 2015), 2015–2017. Retrieved from http://www.communityview.ca/pdfs/2016_SHR_immunization_activities.pdf

Saskatoon Health Region. (2017). *Saskatoon Health Region Policy: 7311-20-013*. Retrieved from https://www.saskatoonhealthregion.ca/about/RWPolicies/7311-20-013.pdf

Saskatoon Health Region. (2018a). Building health equity. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/21161898

Saskatoon Health Region. (2018b). Child Health Clinics - Location. Retrieved August 10, 2018, from https://www.saskatoonhealthregion.ca/locations_services/Services/Healthy-Families/Pages/CHC-Locations.aspx

Saskatoon Health Region. (2018c). Daily Visual Management. Retrieved August 20, 2018, from https://www.saskatoonhealthregion.ca/about/PFMS/Pages/Daily-Visual-Management.aspx

Saskatoon Health Region. (2018d). Healthy Mother, Healthy Baby. Retrieved August 15, 2018, from https://www.saskatoonhealthregion.ca/locations_services/Services/Healthy-Mother

Scutchfield, F. D., Howard, A. F., & Mays, G. P. (2012). Public health services and systems research: An afterword. *American Journal of Preventive Medicine*, *42*(5 SUPPL. 1), S84–S86. https://doi.org/10.1016/j.amepre.2012.01.024

Scutchfield, F. D., & Ingram, R. C. (2013). Public Health Systems and Services Research : Building the Evidence Base to Improve Public Health Practice. *Public Health Reviews*, *35*(1), 1–19.

Shah, S. N., Russo, E. T., Earl, T. R., & Kuo, T. (2014). Measuring and Monitoring Progress Toward Health Equity : Local Challenges for Public Health. *Prev Chronic Dis*, *11*, 1–9.

Shankardass, K.; Solar, O.; Murphy, K.; Freiler, A.; Bobbili, S.; Bayoumi, A.; O'Campo, P. (2011). Getting Started with Health in All Policies : A Resource Pack Health in All Policies : A Snapshot for Ontario, (February 2011).

Simone, B., Balasegaram, S., Gobin, M., Anderson, C., Charlett, A., Coole, L., Maguire, H., Nichols, T., Rawlings, C., Ramsay, M., Oliver, I. (2014). Evaluation of the measles, mumps and rubella vaccination catch-up campaign in England in 2013. *Vaccine*, *32*(36), 4681–4688. https://doi.org/10.1016/j.vaccine.2014.05.077

Skocpol, T. (2001). Targeting with Universalism: Politically Viable Policies to Combat Poverty in the United States. In P. E. Jencks, C.; Peterson (Ed.), *The Urban Underclass* (pp. 411–436). Brookings Institute Press.

Smith, K. E. (2007). Health inequalities in Scotland and England: the contrasting journeys of ideas from research into policy. *Social Science and Medicine*, *64*(7), 1438–1449. https://doi.org/10.1016/j.socscimed.2006.11.008

Smith, P. J., Santoli, J. M., Chu, S. Y., Ochoa, D. Q., & Rodewald, L. E. (2005). The Association Between Having a Medical Home and Vaccination Coverage Among Children Eligible for the Vaccines for Children Program. *Pediatrics*, *116*(1), 8–10. https://doi.org/10.1542/peds.2004-1058

Smith, W. R. (2015). The 2011 National Household Survey - the complete statistical story. Retrieved September 6, 2018, from https://www.statcan.gc.ca/eng/blog-blogue/cs-sc/2011NHSstory

Solar, O., & Irwin, A. (2010). A Conceptual Framework for Action on the Social Determinants of Health.

Social Determinants of Health Discussion Paper 2 (Policy and Practice), 79. World Health Organization. https://doi.org/ISBN 978 92 4 150085 2

Sram, I., Ashton, J., Sram, I., Ashton, J., West, N., & Ashton, J. (2015). Linked references are available on JSTOR for this article : Millennium report to Sir Edwin Chadwick to, *317*(7158), 592–596.

Sreeramareddy, C. T., & Sathyanarayana, T. N. (2013). Decentralised versus centralised governance of health services (Protocol). *Cochrane Systematic Review*, (11). https://doi.org/10.1002/14651858.CD010830.www.cochranelibrary.com

SRNA. (2013). *Standards and Foundation Competencies for the Practice of Registered Nurses*. Retrieved from https://srna.org/wp-content/uploads/2017/09/Standards_and_Foundation_2013_06_10_Web.pdf

Statistics Canada. (2014). Postal Code Conversion File Plus (PCCF +) Version 6A, Reference Guide, (82), 57. https://doi.org/Minister of Industry. Statistics Canada Catalogue no. 82-E0086-XDB

Statistics Canada. (2018). Dissemination Area. Retrieved August 20, 2018, from https://www12.statcan.gc.ca/census-recensement/2011/ref/dict/geo021-eng.cfm

Stikes, R., & Barbier, D. (2013). Applying the plan-do-study-act model to increase the use of kangaroo care. *Journal of Nursing Management*, *21*(1), 70–78. https://doi.org/10.1111/jonm.12021

Stopka, T. J., Krawczyk, C., Gradziel, P., & Geraghty, E. M. (2014). Use of Spatial Epidemiology and Hot Spot Analysis to Target Women Eligible for Prenatal Women, Infants, and Children Services. *American Journal of Public Health*, *104*(1), 183–189. https://doi.org/10.2105/AJPH.2013.301769

Stoto, M. A. (2008). Regionalization in Local Public Health Systems : Variation in Rationale, Implementation, and Impact on Public Health Preparedness, *123*(August 2008), 441–449.

Strand, M., & Fosse, E. (2011). Tackling health inequalities in Norway: Applying linear and non-linear models in the policy-making process. *Critical Public Health*, *21*(3), 373–381. https://doi.org/10.1080/09581596.2010.492210

Strosher, H. W., MacDonald, M., & Hancock, T. (2011). Advancing Public Health Systems and Services Research in Canada: Developing a Pan-Canadian Agenda. *Public Health Systems and Services Research*, 1–67.

Sundquist, S., Dunlop, T., Wright, J., & Findlater, R. (2011). *2010 Annual Immunization Report*.

Swamy, N., Hart, J., Lindly, O., Van Wave, T. W., Monroe, J. A., Mattison, S., … N. C. C. P. (2012). A National Research Agenda for Public Health Services and Systems. *American Journal of Preventive Medicine*, *42*(5), S72–S78. https://doi.org/DOI 10.1016/j.amepre.2012.01.026

Szilagyi, P. G., Schaffer, S., Shone, L., Barth, R., Humiston, S. G., Sandler, M., Rodewald, L.E. (2002). Reducing Geographic, Racial, and Ethnic Disparities in Childhood Immunization Rates by Using Reminder/Recall Interventions in Urban Primary Care Practices. *Pediatrics.* 110(5).

Szilagyi, P., Vann, J., Bordley, C., Chelminiski, A. E., Kraus, R. M., Margolis, P. A., Rodewald, L.E., Jacobson Vann, J.C. (2002). Interventions aimed at improving immunization rates. *Cochrane Database of Systematic Reviews*.

Taylor, P. S. (2014). Public Health Officers should focus on disease - not politics. *Globe and Mail*.

The Igham County Health Department. (2006). Tackling Health Inequities Through Public Health Practice : A Handbook for Action. *Public Health*, *125*(3), 174–175. https://doi.org/10.1016/j.puhe.2010.11.008

The National Collaborating Centre for Determinants of Health. (2012). *Improving Health Equity in Saskatoon : From Data to Action*. Antigonish, NS.

The National Collaborating Centre for Determinants of Health. (2013). *Universal and Targetted Approaches to Health Equity*.

Thomas, C. W., Corso, L., & Monroe, J. A. (2015). The Value of the "System" in Public Health Services and Systems. *American Journal of Public Health*, *105*(Cdc), 147–150. https://doi.org/10.2105/AJPH.2015.302624

Tjepkema, M., Wilkins, R., & Long, A. (2013). Cause-specific mortality by income adequacy in Canada : A 16-year follow-up study, (82).

UNICEF. (2017). Canadian Supplement to the State of the World's Children 2009; Aboriginal children's health: Leaving no child behind. Received August 20, 2018, from http://www.unicef.ca/sites/default/files/imce_uploads/DISCOVER/OUR WORK/ADVOCACY/DOMESTIC/POLICY ADVOCACY/DOCS/Leaving no child behind 09.pdf

University of Kentucky, & Robert Wood Johnson Foundation. (2017). National Longitudinal Survey of Public Health Systems.

Van Aerde, J. (2016). Has regionalization of the Canadian health system contributed to better health ? *Canadian Journal of Physician Leadership*, *2*(3), 65–70.

Vancouver Coastal Health. (2011). *Tackling Health Inequities in Vancouver Coastal Health*.

Vancouver Coastal Health. (2018). Community Health Profiles. Retrieved August 20, 2018, from http://www.vch.ca/public-health/healthy-communities-population-health/community-health-profiles

W.H.O. (2018). Social Determinants of Health. Retrieved from http://www.who.int/social_determinants/en/

Wasserman, J., Jacobson, P., Lurie, N., Nelson, C., Ricci, K., Shea, M., Zazzali, J., Nelson, M.I. (2006). *Organizing state and local health departments for public health preparedness*. RAND Corporation.

WHO European Region. (2013). *The Guide to Tailoring Immunization Programmes (TIP)*. Retrieved from http://www.euro.who.int/__data/assets/pdf_file/0003/187347/The-Guide-to-Tailoring-Immunization-Programmes-TIP.pdf?ua=1

Winnipeg Regional Health Authority. (2012). *Winnipeg Regional Health Authority's Position Statement on Health Equity*.

Wright, J. A., & Polack, C. (2006). Understanding variation in measles-mumps-rubella immunization coverage - A population-based study. *European Journal of Public Health*, *16*(2), 137–142. https://doi.org/10.1093/eurpub/cki194

Young, F. Y. F., Hill, B., & Point, N. (2014). The Use of 5S in Healthcare Services : a Literature Review. *International Journal of Business and Social Science*, *5*(10), 240–248.

Your Alberta. (2014). Determinants of immunization status at two years of age in Alberta. Retrieved from https://www.youtube.com/watch?v=3DJnH7xeknQ

Zhang, x, Saani, H, Chung, J. (2016). The evolution of income mobility in Canada: Evidence from the Longitudinal Administrative Databank, 1982 to 2012. *Statistics Canada: Income Research Paper Series.* ISSN: 1707-2840.

Zimmerman, R. K., Nowalk, M. P., Mieczkowski, T. A., Mainzer, H. M., Jewell, I. K., & Raymund, M.

(2001). The Vaccines for Children Program Policies, Satisfaction, and Vaccine Delivery. *American Journal of Preventative Medicine*, *21*(4), 243–249.

Appendix: Qualitative Interview Guide

Contents

1. Introduction:

This document explicates the rationale and content of qualitative interview questions conducted in this study.

The Interview Framework (Figure 1) was the guide with which I began to assess the descriptions of, and the interventions conducted by, each case's public health program. It is a representation of what it is I began to attempt to detect in my investigations of evidence and equity-based MMR immunization coverage public health policy-making. Upon investigating the four case public health programs it became apparent that not all of the original study framework elements could be assessed across all cases. This was due to fact that there were significant informational asymmetries between cases; at the depth I was investigating, specific information could be elucidating from some cities, and not others. To keep the forms of data across the cases consistent, a parsimonious second-iteration framework was constructed (Figure 4).

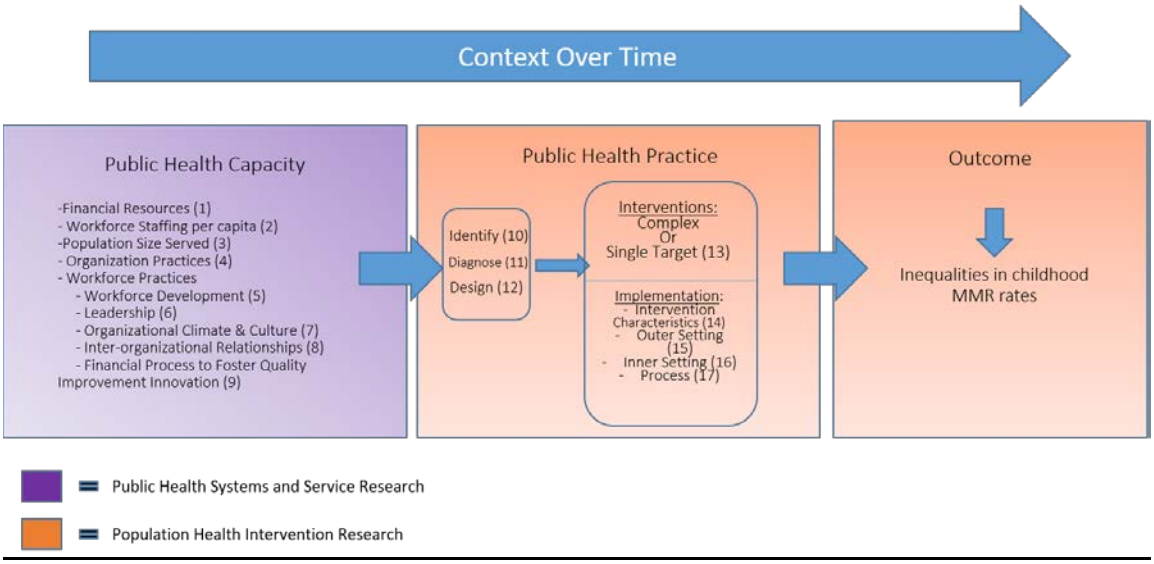


Figure 0-1: Interview framework

2. Guide to bridging Figure 1 with the interview questions:

The Interview Framework is a consolidation of other frameworks and models derived from four peer-reviewed sources across the fields of public health systems and service research and implementation sciences. The framework represents a hypothesis of how I think evidence and equity-based policymaking occurs in local public health practice at an institutional level, based on my review of the literature. Through my qualitative assessment of four local public health units, I will test this hypothesis, and revise my framework based on the synthesis of my results.

Please utilize this document alongside a picture of the framework and the questions themselves. The bracketed numbers within the text allows the reader to refer the interview questions to the corresponding number on the framework itself.

2.1 Public Health Capacity:

The "Public Health Capacity" section of the framework is derived from Guyon & Perreault (2016) paper, which summarized findings from other studies, revealing the following elements of a high performing public health program:

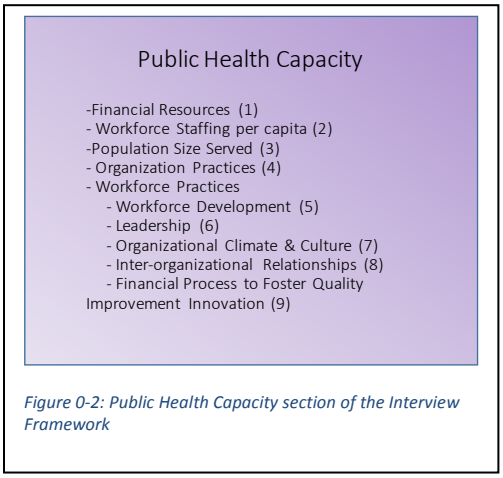


Figure 0-2: Public Health Capacity section of the Interview Framework

"Currently, there appears to be sufficient evidence to support a relationship between four structural elements and the performance of public health systems. Increased productivity in public health systems has consistently been associated with: 1) increased financial resources; 2) increased staffing per capita; 3) a population size between 50,000 and 500,000; and 4) specific administrative features with respect to workforce development, leadership, organizational climate and culture, inter-organizational relationships and partnerships, and specific financial processes. Furthermore, two of these elements are significantly associated with improved population health outcomes (efficiency): increased financial resources and increased staffing per capita" (p.327).

The "administrative features" subcategories mentioned are expanded in Brownson (2009) review of evidence-fostering practices within public health. The following drivers all have shown to increase effectiveness of public health practice:

- Strong workforce development through in-service training and quality improvement initiatives (5)
- Leadership's quality improvement agendas, skills, and culture of participatory decision-making (6)
- Free-flow information channels within organization, support for innovation, communication throughout organizational structure (7)
- Formal partnerships with schools, hospitals, community organizations, private sector, university, law enforcement and aligned missions with those organizations (8)
- Outcomes-based quality improvement, and resources allocated for evidence-based decision-making (9)

An assumption in my study is that "performance of public health systems" includes "equity" being a measure of success, as equity is a core competency of public health practice in Canada.

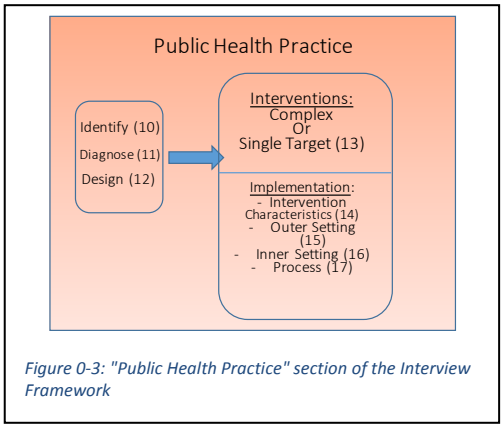


Figure 0-3: "Public Health Practice" section of the Interview Framework

2.2 Public Health Practice:

My framework assumes that a capacity to use evidence would allow a public health institutions to engage in the WHO recommended process of developing tailored immunization programming (2013). This is why "Identify, Diagnose, Design" comes next in the framework.

Crocker-Buque et al (2016) categorizes interventions to reduce inequalities in childhood immunization coverage into single target interventions - only utilizing reminder-recall systems, for example – and complex interventions that utilize more than one interventions as a part of an overall strategy.

The context in which these interventions were deployed can be revealed using the Consolidated Framework for Implementation Research (Damschroder et. al, 2009), of which the following constructs will be investigated:

- Interventions Characteristics: Questions that unpack specifics of the interventions used
- Outer Setting: What impact do signals by patients, other public health institutions, and other external bodies have on intervention implementation
- Inner Setting: What structural characteristics, networks, culture and incentives are in place within the organization to facilitate implementation
- Process: Insights into the stages of planning, engaging, executing and evaluating interventions

3. Final Study Framework:

The following study framework is the culmination of perspectives and theories presented from the frameworks from the literature and the original iteration of the Interview Framework. This study framework 'bounded' my qualitative and quantitative data such that the data across cases would be in similar forms, allowing me to better compare cases.

The "Public Health Practice" domain represents the institutional characteristics and the policy process associated with each of the public health programs. This section considers the "how" - PHSSR-based results detected using questions based on the Consolidated Framework for Implementation Research and the WHO TIP Policy Process Framework. The "Health-Inequalities-Over-Time One-Dose by Age 2 MMR Immunization Coverage Rates" are the outcomes detected by the quantitative analyses of 2009-2015 MMR coverage data. The "Childhood Immunization Interventions" section organizes the interventions detected over the study period according to when they were deployed across the study timeline, and the length of intervention: whether the intervention was a one-off intervention or an ongoing intervention. This section answers the "what" - a PHIR-based inquiry about the actual interventions deployed and their characteristics. The results section of the dissertation reports each case within this framework to minimally organize the qualitative and quantitative results.

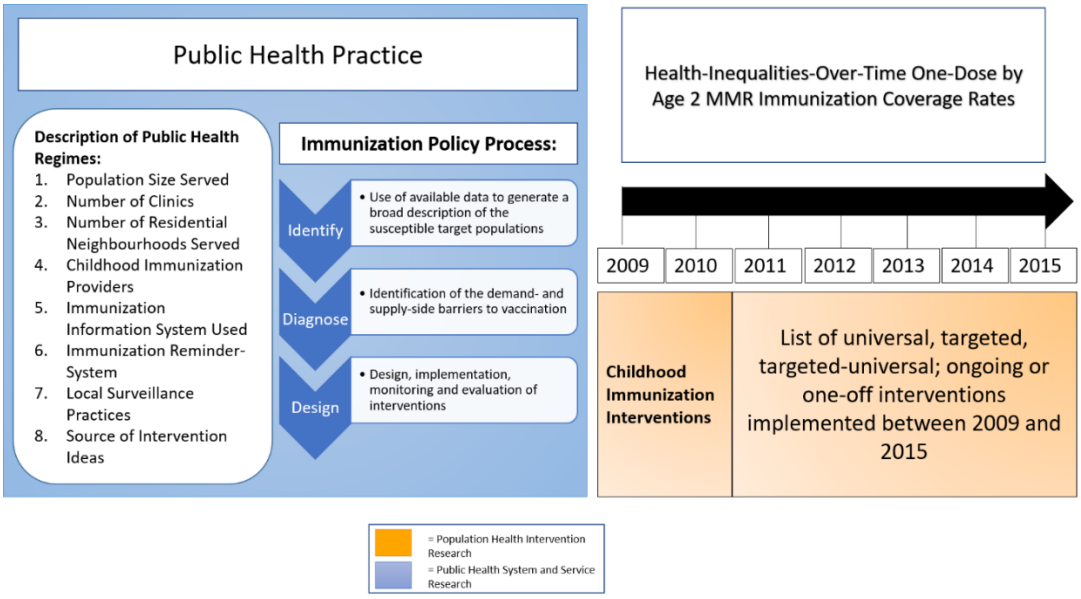


Figure 0-4: Final Study Framework

4. Interview Questions:

Opening Script:
Oral Consent Telephone script:

Thilina Bandara

***NOTE: Copy of PARTICIPANT INFORMATION AND CONSENT FORM will be emailed to the participant at the time of the interview.**

Hello _____,

I am Thilina Bandara, PhD Student at the University of Saskatchewan.

As we have discussed before over email correspondence, I am contacting you today to conduct a phone interview with you to discuss public health practice you and your public health unit engage in.

The interview will take approximately 45 mins and will be recorded for transcription purposes. If at any point you want the recording to be turned off, or you wish any information to be removed from the recording after, please let me know.

There are no anticipated risks in this study.

Though there are no direct benefits to you for participating in this research study, the study will help me understand how public health units can help reduce equity gaps in childhood immunization coverage.

Because of the nature of the data, I cannot guarantee you data will be confidential and it may be possible that others will know what you have reported. Your responses however, will not be attributed to you by name.

Your participation is completely voluntary.

You have the right to withdraw from the study at any time without penalty. If you would like to withdraw from the study, please email me at tsb488@mail.usask.ca and I will remove your unit from the study.

You will receive no payment for participating in the study.

If you have any questions you may contact Dr. Neudorf or I at any time.

Do you orally consent to participate in the study?

Background related to organization:

1. What is your position in your public health agency?
2. Could you tell me a little bit about your department & if you know, its recent history?
3. What percentage of the health budget is dedicated to public health in your jurisdiction? **(1)**

4. Has there been a growth of public health budgets over the years, relative to the growth in the total health budget?

5. How many citizens does your public health department serve? **(3)**

6. How many staff does your public health department have? **(2)**

Capacity questions:

7. What is the overall mandate of your unit?

a. *Do they mention equity?

8. Regarding immunizations, do you have performance targets?

9. What are the performance/quality indicators (outcomes, percentage coverage) your unit utilize? (7)

a. *Antigen? Age? Geographical breakdown? High risk? Safety?

b. *May mention the source of targets (provincial ministries? Federal agency?) **(15)**

c. *If they mention equity:

i. How does equity effect your day to day work? **(7)**

10. Could you walk me through how your unit makes strategic planning decisions about immunization programming? **(10,11,12)**

a. Do they mention anything close to "Identify, diagnose, design" WHO framework?

11. Could you name some of the human resources and skills your unit requires to accomplish your programming goals? For example, who are some non-health care related people you need to for your day-to-day immunization programming? **(5)**

a. *Try to remember if they had mentioned clerks, data entry, community planners, etc.

i. Is their approach opportunistic (people who need immunizations come to them?); or is it more targeted (utilize a systematic way to be proactive)?

b. Does an employee in your unit usually come with these skills, or to what degree do you train your employees? **(5)**

12. What are some strategies your unit uses to increase immunization rates in the general population, or in certain subgroups? When did those occur and when did they end?

a. *Look for complex vs. single interventions **(13)**

b. *Look for how they use existing data for the purposes of planning

c. *Look for interorganizational partnerships and linkages (school, religious organizations, primary care centers, etc.) **(8)**

13. How did you know whether it was effective or not?

14. Where do the programming and policy ideas come from in your organization? In other words, when your unit is alerted to public health issue, what is the procedure utilized to find a programming or policy solution? **(14, 15, 16)**

15. Once a program is in place, what steps would the person in charge of that program take to assess the utility of the program? **(15,16)**

a. *Mentions of cost barriers?

b. *Assess the use of top down or bottom up policy-making

c. *Assess use of any monitoring feedback they may utilize **(17)**

Public Health Practice:

Let get back to specific interventions that your unit has utilized…

Intervention Source: (14)

16. Who developed the intervention?

17. What are the reasons you chose this intervention over others in your setting?

18. Who decided to implement the intervention?

19. (Assess from question 11) How was the decision made to implement the intervention?

Evidence Strength and Quality: (14)

20. What kind of information or evidence are you aware of that shows whether or not the intervention will work in your setting?

a. From your own research? Co-workers? Peer-reviewed? Practice Guidelines?

21. What do influential stakeholders think of the intervention?

a. What do administrators and other leaders think of the intervention?

22. What kind of supporting evidence or proof is needed about the effectiveness of the intervention to get staff on board?

• Corroborate all interview data with document analysis results. For example, look for evaluations that may or may not have been done.

5. References:

1. Brownson, R., Chriui, J., Stamatakis, K. (2009). Understanding evidence-based public health policy. *American Journal of Public Health.* 99(9):1576-1583.
2. Guyon, A., Perreault, R. (2016). Public health systems under stack in Canada: Evidence on public health system performance challenges arbitrary reform. *Canadian Journal of Public Health.* 107(2): 326-329.
3. Crocker-Buque, T., Edelstein, M., & Mounier-Jack, S. (2016). Interventions to reduce inequalities in vaccine uptake in children and adolescents aged < 19 years : a systematic review. *British Medical Journal*. 1–11. https://doi.org/10.1136/jech-2016-207572
4. Damschroder, L.J., Aron, D.C., Keith, R.E., Kirsh, S.R., Alexander, J.A. et Lowery, J.C. (2009). Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. *Implementation Science*. 4: 50. doi: 10.1186/1748-5908-4-50.
5. WHO European Region. (2013). *The Guide to Tailoring Immunization Programmes (TIP)*. Retrieved from http://www.euro.who.int/__data/assets/pdf_file/0003/187347/The-Guide-to-Tailoring-Immunization-Programmes-TIP.pdf?ua=1